Vol. 14 MARCH, 1931 No. 3

Journal

of the

American Ceramic Society

Abstracts
Vol. 10, No. 3

Bulletin
Vol. 10, No. 3

A Monthly *Journal* Devoted to the Arts and Sciences
Related to the Silicate Industries

Publication Office: 20th & Northampton Sts., Easton, Pa.

Editorial and Advertising Offices: 2525 N. High St., Columbus, Ohio.

Executive Office: 2525 N. High St., Columbus, Ohio.

Committee on Publications: F. K. Pence, *Chairman;* A. Silverman, L. Navias, L. J. Trostel, A. E. R. Westman, Ross C. Purdy.

Entered as second class matter at the post office at Easton, Pa., under the Act of March 3, 1879.

(Copyright 1931, American Ceramic Society)

Subscription Fifteen dollars a year. Single numbers one dollar and one-half
(Foreign and Canadian postage, 50c additional on subscriptions)

Established 1869

B. F. DRAKENFELD & CO.

Incorporated

45-7 Park Place New York

Pioneer and Premier Producers of
Vitrifiable Colors in America

OXIDE COLORS

FOR ENAMELERS

Manufactured Throughout under
Strict Chemical Control

SPECIAL AND UNIQUE COLOR SHADES

Prepared to Meet Individual
Requirements

Order Direct or through Following Agents

FERRO ENAMEL SUPPLY CO.
CLEVELAND, OHIO

BRAUN CORPORATION
LOS ANGELES, CALIF.

Measure Temperatures
with Motor-driven Pyrometers

With L&N **POTENTIOMETER PYROMETERS**

Actual width of the L & N Chart is 9¾ inches

NOT only is the L & N Potentiometer Pyrometer* the most accurate in industry; it is also the most rugged. Its potentiometer detecting circuit is extremely sensitive and reliable. Its measuring mechanism is driven positively by a powerful electric motor. Parts are big and strong. Bearings are heavy. There is plenty of power to operate this temperature-measuring machine—a machine which is sturdy enough to withstand every-day shop service.

The same workman who supervises fans or similar equipment, or the operator himself, can easily take care of L & N Potentiometer Pyrometers; they require no trained supervision.

L & N Catalog 84-K lists L & N Potentiometer Pyrometers for automatic temperature control. Catalog 87-K lists them for recording and for indicating. Special bulletins outline their application to various industries.

** Information as to the advantages of L & N Potentiometers will be sent on request.*

L&N **LEEDS & NORTHRUP COMPANY**
4901 STENTON AVENUE PHILADELPHIA, PA.

LEEDS & NORTHRUP

P-210 **Cleveland Chicago Houston Los Angeles San Francisco**

Different Pyrometers—The Most Accurate Pyrometers In Industry
For Indicating, for Recording and for Controlling Automatically

"The Birth of Eve"

This Porcelain "Painting" was *Fired Fifty-Eight Times*

"THE Birth of Eve"—a superb work by the well known European enamelers, Plurima, is probably one of the rarest "enameled canvases" known to man.

Beneath the exquisite figure work and delicate color gradations is Ingot Iron, the base metal preferred by exacting enamelers everywhere. Exposed to the grueling heat of *fifty-eight separate burnings*, this pure, uniform iron endured it all *without once warping or blistering.*

Although it is improbable that you will ever have to fire a piece fifty-eight times, it is reassuring to know that you are working with an enameling iron that met that extreme test successfully.

If you are not using Ingot Iron, it would be well to investigate its economies and efficiencies. Write to the office nearest you for complete information.

THE AMERICAN ROLLING MILL CO.
Executive Offices: Middletown, Ohio
Export: The ARMCO International Corporation

—District Offices—

Chicago — Cincinnati — Cleveland — Detroit
New York — Philadelphia — Pittsburgh
St. Louis — San Francisco

PRODUCERS OF

INGOT IRON

ENAMELING SHEETS

"THE WORLD'S STANDARD ENAMELING IRON"

(When writing to advertisers, please mention the JOURNAL)

CLEAN, FILTERED AIR

is a real help to workers in dusty atmospheres

Pure Air is of prime importance to shop safety practice. By helping to conserve the workman's energy, keeping him alert and on the job, fresh air does a good bit toward increasing production efficiency and at the same time minimizes the likelihood of serious accidents. It is a generally recognized fact that the major portion of all industrial accidents occur in the final quarter of the day's working period when the workmen have usually become fatigued and off guard.

The Willson Bag Respirator is popular with the men who wear it because of such features as the comfortable face contact obtained with only slight headband pressure . . . . the large filtering area permits free, easy breathing with no speech interference . . . . full freedom of vision is allowed and eye glasses or safety goggles may be worn . . . . all parts are replaceable without tools; the bag filter is washable and may be used many times over. Price with one extra filter, $2.00 f.o.b. shipping point.

WILLSON PRODUCTS, Inc.
READING, PENNSYLVANIA

Of Value to You
is our
Long Record
of
Plant Proven Dependability
for
Constancy in Quality
due to
Laboratory Controlled Inspection
and
Nature's Most Uniform Deposits
of
Ball, Sagger, Enamel, Wad and Fire CLAYS

Mined and Sold by

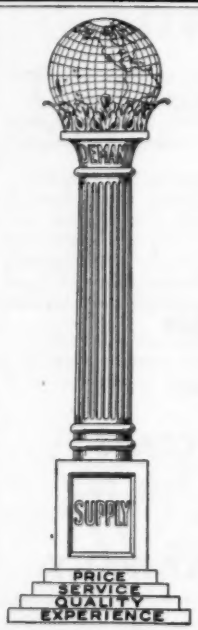
KENTUCKY-TENNESSEE CLAY COMPANY
Mayfield, Kentucky

PENNSYLVANIA PULVERIZING CO.
LEWISTOWN, PA.

Potters Flint **Placing Sand**

SALES OFFICE

323 Fourth Avenue
Pittsburgh, Pa.



EDGAR CLAYS

The invaluable experience of men producing highest quality clays is something for every clay user to consider. The name

EDGAR CLAYS

in the ceramic industry is comparable to the word Sterling on silver—it is synonymous with highest QUALITY and SERVICE. Users of

EDGAR CLAYS

secure a service in which they can place utmost confidence and reliability at all times. It is the pleasure of the Edgar organization to render technical and other assistance as may be desired by users and prospective users, without obligation.

EDGAR CLAYS are PRICED RIGHT, and insure a cordial contact between buyer and seller of such quality material.

Department of Sales

THE EDGAR PLASTIC KAOLIN CO.
EDGAR BROTHERS CO.

Home Office
Metuchen, N. J.

New York Office
50 Church St.

Ceramic and Enameling Clays—Filler and Coating Clays for Paper, Rubber and Shade Cloth

Table of Contents

MARCH, 1931

The Journal

The Influence of Time on the Maturing Temperature of Whiteware Bodies. I—Norton and Hodgdon 177
The Influence of Time on the Maturing Temperature of Whiteware Bodies. II—Norton, Jr 192
Effects of Autoclave Treatments on Ceramic Bodies and Clays—Holscher 207
The Electrical Dewatering of Clay Suspensions—Curtis 219

Ceramic Abstracts

161

The Bulletin

Editorial

To Whom Are You Indebted? 55

Activities of the Society

Biographical Sketch of Dr. M. Luckiesh 57
Audit Report, Year 1930 58
A Charter Member Writes 61
Secretary's Letters 62

Local Section News:

Baltimore-Washington Section 62
Pacific Northwest Section 63
St. Louis Section 64
California Section 64
New Members Received in January 65
Roster Changes in January 66

Notes and News

Ceramic School Notes:

New York State School of Clay-Working and Ceramics 67
Everyday Ceramics—Fréchette 68

Calendar of Meetings 71

Advertisers' Index 25

FOR VALUE RECEIVED

A GREAT MANY PEOPLE will tell you that the biggest single service that five cents can buy today is a local telephone call. Without question, it is big value . . . and value that steadily grows as new telephones come into your neighborhood.

There are times when telephone service is priceless . . . when the ability to call instantly a doctor, a policeman, or the fire department could not be measured in terms of money.

But it is not alone the emergencies that give the telephone its value. There are the commonplaces of every-day conversation . . . in the home, the shop, the office . . . whenever you wish two-way communication with any one, almost anywhere.

The telephone has become such an every-day, matter-of-fact convenience—like running water and electricity—that it is natural to take it for granted. It is well to pause occasionally and consider the nation-wide organization of men, money, and materials that makes this vital service possible, and at such low cost.

Here is a system of the public, for the public . . . run on the barest margin of profit consistent with service, security, and expansion. A service that grows as the community grows . . . placing within the reach of an increasing number the means to talk back and forth with people in the next block, the next county, a distant state, a foreign country, or on a ship at sea!

No other money that you spend can bring you more actual value.

★ *AMERICAN TELEPHONE AND TELEGRAPH COMPANY* ★

(When writing to advertisers, please mention the JOURNAL)

THE INFLUENCE OF TIME ON THE MATURING TEMPERATURE OF WHITEWARE BODIES. I.[1]

By F. H. Norton[2] and F. B. Hodgdon[3]

ABSTRACT

In this investigation quantitative relations have been established between the time and temperature effects in the maturing of whiteware bodies. Six typical commercial whiteware bodies were used. Similar shrinkage and porosity curves were obtained for different firing times but the longer the time the lower the curve was shifted on the temperature scale. It was found that in all cases the usual logarithmic law relating temperature with the rate of reaction applied. The constant, however, was not the same for all bodies. The microstructure of these bodies will be dealt with in Part II of this paper.

I. Purpose

A great many qualitative studies have been made on the effect of time and temperature on ceramic products, but as far as is known, there have been no results showing the logical quantitative relation between these two factors. It was considered of importance to investigate the influence of temperature on the rate of reaction to ascertain if there were not some general law which could be applied to the firing of whiteware and perhaps of all ceramic bodies.

The extensive use of tunnel kilns in modern pottery practice and the use of open settings in the place of saggers make it possible to fire whiteware at a much higher rate than was previously considered possible. It is obvious that the more rapidly the ware can be fired, the more production is obtained from a given kiln investment and the lower will be the fuel cost. Furthermore, the rapid firing in some cases is a decided advantage in producing special orders promptly.

The questions that are asked in this connection are: What is the relation between the firing temperature and the time of firing? How fast is it safe to fire a piece of whiteware?

It is the purpose of this investigation to provide answers for these questions. While the general conclusions may apply broadly to any ceramic body, the specific data deals with whiteware.

II. Bodies Tested

In the following table are given the compositions, by dry weight, of the six whiteware bodies tested. Bodies 1 to 4 were kindly supplied by large concerns producing ware from them on a commercial scale. Body No. 5,

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received November 10, 1930.

[2] Assistant Professor of Ceramics, Massachusetts Institute of Technology.

[3] Assistant in Ceramics, Massachusetts Institute of Technology.

vitrified chinaware, was made up in the laboratory, and the Parian body, No. 6, which has only a limited commercial use, was also made up for this purpose. All of the bodies were made up in the form of a slip for casting.

Material	Electrical porcelain No. 1 (%)	Sanitary body No. 2 (%)	Earthenware (ivory) No. 3 (%)	Earthenware (white) No. 4 (%)	Vitrified chinaware No. 5 (%)	Parian body No. 6 (%)
Kaolin	20.6	24.5	21.6	34.0	39.0	30
Ball clay	26.0	25.5	35.4*	20.3*	7.0	10
Flint	18.6	24.0	32.7	33.2	38.5	
Feldspar	34.8	25.5	10.3	12.5	15.0	60
Whiting		0.5			1.5	

* Contains 26% of water.

III. Method of Molding the Specimens

At the beginning of this investigation considerable thought was given to the best size of specimen. It was necessary to use a kiln small enough to give a quick temperature rise, and yet large enough to take at least twelve specimens without piling one on top of the other. These considerations would lead to a small-sized specimen. On the other hand, precision of measuring the shrinkage and porosity would be greater with larger specimens, but the difficulty of insuring a uniform temperature over all the specimens would be increased. Also, it was thought advisable to keep the thickness of the specimens down approximately to that of commercial whiteware so that there would be no question that the center of the specimen reached an equilibrium condition in the shorter runs.

After considering the available kilns it was decided that the specimen size must be kept down to a length of 2 inches, a width of $^1/_2$ inch, and a thickness of $^3/_{16}$ inch. This small size, of course, made it necessary to sacrifice some precision in the measurements of shrinkage and porosity, but it assured an even temperature throughout the useful zone of the kiln. If another test were to be made of a similar nature, it would be advisable to construct a slightly larger kiln and use specimens of twice the length and width. This would permit the attainment of more precise values of shrinkage and porosity.

A number of methods suggested themselves for forming the specimens. It was essential that they all be made as nearly as possible under the same conditions and free from laminations or flaws. It was therefore decided to cast the specimens in a gang mold, and while they were still soft to repress them in a brass mold under a uniform pressure of three hundred pounds on the flat surface. This gave specimens that were uniform in size and free from flaws.

Before removing the specimens from the mold a number was placed on each end of the flat surface with a small steel stamp. Thus, each body

had its own number. In addition to this, each specimen had a second number scratched on it just before it was placed in the kiln, which referred to the firing conditions.

IV. Kiln for Firing Specimens

The kiln for firing the specimens required considerable study, as it was necessary to have a working chamber with a uniform temperature. It must have a quick temperature rise, and the maximum temperature should be capable of being held closely to any definite value for considerable lengths of time. It was also necessary always to maintain a slightly oxidizing atmosphere in the kiln.

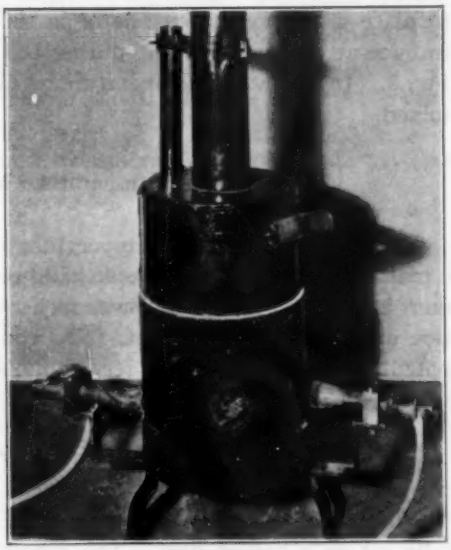


FIG. 1.

In addition to this a kiln was needed which could run unattended during the night, so that it would not be necessary to make special provision for night runs.

The kiln as finally built is shown in Fig. 1. The heat is supplied to the furnace by two large Méker atmospheric-type burners which act tangentially. The gases pass spirally around the specimen chamber and pass out through a special cover to the short stack which is regulated in height to give a slightly oxidizing atmosphere during the firing. The specimens are set on their edges with about $^1/_8$ inch between them, and a thermocouple is placed in their center so that it will indicate accurately the temperatures of the specimens themselves. Temperatures as high as 1450°C can be readily attained with this kiln.

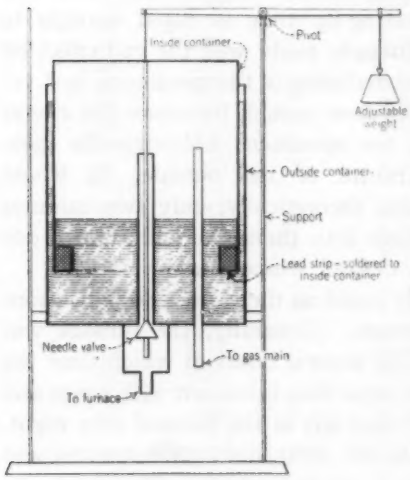


FIG. 2.

The temperature of the kiln is regulated by changing the gas supply, but due to the irregularities in the gas pressure the furnace temperature would not remain as constant as desired. Therefore, it was necessary to place a gas-pressure regulator in the line to hold the pressure on the furnace at a constant value during the run. This regulator is shown in Fig. 2. In this way a temperature regulation of ± 5°C was readily maintained.

V. Temperature Measurement

As previously stated the temperature of the specimens was measured with a platinum couple. This couple had been carefully calibrated at the aluminum and copper points and was rechecked near the end of the investigation and found to be correct. The couple was connected to a recording potentiometer which gave a record of each run.

VI. Firing Procedure

When making a run the specimens were measured, numbered, and carefully set on a bed of flint. The furnace was closed and the couple inserted through the cover. The burners were then lighted and the furnace brought up to the desired temperature on approximately the same schedule for each test as shown by the curve in Fig. 3. It will be evident that this heating-up time is rapid enough to eliminate fairly well the end effect on the maturing of the specimens, and yet it is slow enough to assure the center of the specimens following the temperature of the outside. It would take, theoretically, only two minutes for a specimen of this thickness to come into thermal equilibrium if one side were suddenly brought up to the desired temperature.

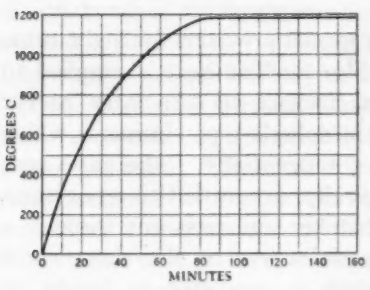


FIG. 3.

The cooling of the furnace was fairly rapid as there were no indications of cracking of the small-sized specimens. Generally, the furnace was shut off and allowed to cool by itself for several hours at which time the specimens would show no color. They were then taken out with tongs and measured, although occasionally they were left in the furnace over night.

Runs were made with a duration of 10, 100, 1000, and 10,000 minutes, and in nearly every case duplicate runs were made for a check. The maximum temperature varied from 1045 to 1300°C.

VII. Shrinkage Measurements

It is believed that the shrinkage measurements indicate most readily and precisely the relative state of maturity of the body. The linear shrinkage of each specimen was determined by means of vernier calipers. In some cases volume shrinkage was also obtained, but this always checked so well with the linear shrinkage measurements that the latter were used exclusively.

In a few cases the specimens were considerably warped in firing. As

TABLE I

ELECTRICAL PORCELAIN BODY NO. 1

Specimen No.	Temp. (deg.)	Time (min.)	Linear shrinkage (%)	Av. linear shrinkage (%)	Porosity (%)	Av. porosity (%)
1	1100	10	3.06		26.55	
2	1100	"	3.05	3.06	27.55	27.05
3	1150	"	7.57			
4	1150	"	6.67	7.12	10.77	10.77
7	1200	"	8.11		2.59	
8	1200	"	8.35	8.23	2.54	2.57
11	1250	"	8.06		0.00	
12	1250	"	8.45		0.61	
13	1250	"	8.77	8.47	0.32	0.31
15	1300	"	7.96		0.00	
16	1300	"	8.13	8.05	0.00	0.00
17	1100	100	5.70		14.89	
18	1100	"	5.70	5.70	16.18	15.54
19	1150	"	7.90			
20	1150	"	7.30	7.60	5.49	5.49
33	1180	"	8.96		0.55	
34	1180	"	8.16	8.56	0.64	0.60
23	1200	"	8.48			
24	1200	"	8.32	8.40	0.00	0.00
27	1260	"	8.16		0.00	
28	1260	"	8.78	8.47	0.00	0.00
29	1275	"	8.18			
30	1275	"	8 00	8.09		
31	1290	"	8.30		0.00	
32	1290	"	7.91	8.11	0.00	0.00
35	1045	1000	3.67		20.41	
36	1045	"	1.02	2.35		20.41
37	1105	"	6.10		8.24	
38	1105	"	6.88	6.49		8.24
39	1140	"	8.30			
40	1140	"	7.93	8.12	0.57	0.57
41	1175	"	8.33		0.00	
42	1175	"	8.16	8.25	0.00	0.00
47	1225	"	8.35		0.00	
48	1225	"	8.35	8.35	0.00	0.00
45	1275	"	7.94	7.94		
51	1050	10,000	5.48			
52	1050	"	5.11	5.30	6.04	6.04
53	1120	"	8.16		0.00	
54	1120	"	8.14	8.15	0.00	0.00

this would naturally introduce some error into the length measurement, the test specimen was re-run in these cases.

VIII. Porosity Measurements

Similar to the shrinkage, the porosity readily indicates the state of

TABLE II

SANITARY BODY No. 2

Specimen No.	Temp. (deg.)	Time (min.)	Linear shrinkage (%)	Av. linear shrinkage (%)	Porosity (%)	Av. porosity (%)
1	1100	10	3.06		26.52	
2	1100	"	3.47	3.27	25.47	26.00
5	1150	"	7.07		7.37	
6	1150	"	7.00	7.04		
7	1150	"			6.47	6.92
9	1200	"	8.32		2.67	
10	1200	"	8.27	8.30	2.76	2.72
15	1250	"	8.33		0.00	
16	1250	"	8.35	8.34		0.00
17	1300	"	7.74		0.00	
18	1300	"	7.69	7.72	0.00	0.00
19	1100	100			14.62	
20	1100	"			14.39	14.51
21	1100	"	5.69			
22	1100	"	5.86	5.78		
23	1150	"	8.32		2.32	
24	1150	"	7.52	7.92	5.45	3.89
27	1180	"	8.32		1.04	
28	1180	"	8.49	8.41	1.12	1.08
29	1200	"			0.00	
30	1200	"			0.00	0.00
31	1200	"	8.46			
32	1200	"	8.48	8.47		
33	1260	"	8.13		0.00	
34	1260	"	8.28	8.21	0.00	0.00
35	1275	"	7.67			
36	1275	"	7.68	7.68		
37	1290	"	7.09		0.00	
38	1290	"	7.47	7.28	0.00	0.00
39	1045	1000	3.84		21.91	
40	1045	"	1.42	2.63		21.91
41	1105	"	7.07		7.50	
42	1105	"	6.69	6.88	7.80	7.65
43	1140	"	8.13		2.54	
44	1140	"	8.30	8.25	2.90	2.72
45	1175	"	8.71		0.00	
46	1175	"	8.49		0.00	
47	1175	"	8.08	8.43		0.00
57	1225	"	8.10		0.00	
58	1225	"	8.06	8.08	0.00	0.00
49	1275	"	7.70		0.00	
50	1275	"	7.47	7.59	0.00	0.00
53	1050	10,000	4.53		13.61	
54	1050	"	4.94	4.74		13.61
55	1120	"	8.08		0.00	
56	1120	"	8.08	8.08	0.00	0.00

maturity. It was found, however, that the porosity measurements were more irregular than the shrinkage measurements, due, it is believed, to laminations or closed pores. The porosity was measured in the usual way by boiling the specimens for three hours and then letting them stand under water over night. A dry weighing and a wet weighing were made, and

TABLE III

IVORY EARTHENWARE BODY NO. 3

Specimen No.	Temp. (deg.)	Time (min.)	Linear shrinkage (%)	Av. linear shrinkage (%)	Porosity (%)	Av. porosity (%)
1	1100	10	1.63		33.84	
2	1100	"	1.83	1.73	33.33	33.58
7	1150	"	3.45		19.56	
8	1150	"	3.57	3.51	21.46	20.51
9	1200	"	5.28		15.53	
10	1200	"	5.50	5.39	15.91	15.72
15	1250	"	6.92		7.94	
16	1250	"	7.12	7.02	7.73	7.84
17	1300	"	7.94		4.32	
18	1300	"	7.93	7.94	2.84	3.58
19	1100	100	2.65		30.56	
20	1100	"	2.65	2.65	39.51	35.04
23	1150	"	4.89		21.21	
24	1150	"	4.07	4.48	25.24	23.23
29	1200	"	7.11		12.63	
30	1200	"	6.91	7.01	11.28	11.96
33	1260	"	7.95		2.65	
34	1260	"		7.95	4.74	3.70
35	1275	"	8.13			
36	1275	"	8.00	8.07		
37	1290	"	8.11		2.44	
38	1290	"	8.33	8.22	1.74	2.09
39	1045	1000	1.62		31.78	
40	1045	"	1.02	1.32	33.05	32.42
41	1105	"	5.59		32.97	
42	1105	"	2.25	3.92	28.31	30.64
43	1140	"	4.47		18.78	
44	1140	"	4.70	4.59	16.93	17.86
47	1175	"	6.30		6.09	
48	1175	"	6.72	6.51	6.75	6.42
57	1225	"	6.53			
58	1225	"	6.72	6.63	6.52	6.52
49	1275	"	7.52		3.41	
50	1275	"	7.56	7.54	2.95	3.18
53	1050	10,000	3.47		27.95	
54	1050	"	2.88	3.18	25.71	26.83
55	1120	"	6.06		12.03	
56	1120	"	5.87	5.97	13.46	12.75

the volume of the specimen was determined with the usual type of mercury volumeter.

IX. Precision of Measurements

The measurement of the temperature was precise to ± 5°C at the couple,

and there was the possibility of as much as ± 5°C difference between the couple and the outside specimen. This would give a maximum possible error of 10°C. It is believed, however, that the average readings are within 5°C. The measurement of length was made to 0.1 mm., and the error

TABLE IV

WHITE EARTHENWARE, BODY NO. 4

Specimen No.	Temp. (deg.)	Time (min.)	Linear shrinkage (%)	Av. linear shrinkage (%)	Porosity (%)	Av. porosity (%)
1	1100	10	1.44		33.94	
2	1100	"	1.84	1.64	33.81	33.88
5	1150	"	3.48		31.37	
6	1150	"	3.91	3.70	28.04	29.71
9	1200	"	5.85			
10	1200	"	5.55	5.70	12.22	12.22
15	1250	"	7.41		6.58	
16	1250	"	7.18	7.30		6.58
17	1300	"	8.47		4.12	
18	1300	"	7.60	8.04	3.67	3.90
19	1100	100	2.46		30.73	
20	1100	"	2.65	2.56		30.73
23	1150	"	5.35		22.50	
24	1150	"	4.90	5.13	25.14	23.82
27	1180	"	6.73		12.92	
28	1180	"	6.55	6.64	11.67	12.30
33	1200	"	7.20			
34	1200	"	7.19	7.20	8.82	
32	1200	"			8.84	8.83
29	1260	"	8.35		3.39	
30	1260	"	8.16	8.26	4.24	3.82
35	1275	"			2.35	
36	1275	"			2.38	2.37
37	1290	"	8.59		1.19	
38	1290	"	8.61	8.60	1.90	1.55
39	1045	1000	1.44		34.98	
40	1045	"	1.23	1.34		34.98
43	1105	"	3.69		29.63	
44	1105	"	3.88	3.79	26.61	28.12
45	1140	"	4.90			
46	1140	"	5.26	5.08		
47	1175	"	6.31			
49	1175	"	7.90	7.11	4.97	
50	1175	"			4.97	4.97
57	1225	"	7.39			
58	1225	"	7.55	7.47	3.93	3.93
42	1275	"	7.77		2.91	
41	1275	"	8.11	7.94	2.38	2.65
53	1050	10,000	4.08			
54	1050	"	3.68	3.88	28.00	28.00
55	1120	"	6.74		10.67	
56	1120	"	7.07	6.91	10.00	10.34

that occurs is due to irregularity of the specimens. The weighing of the specimens is more precise than any of the other factors in the measuring of the porosity and need not be considered. The volume of the specimen was measured to the nearest 0.01 cc.

Taking all of these things into consideration, it is estimated that the maximum error in shrinkage is ± 0.5% and the maximum error in porosity ± 2%, except in the case of the very high porosity values where the results were more erratic.

TABLE V

VITRIFIED CHINAWARE, BODY NO. 5

Specimen No.	Temp. (deg.)	Time (min.)	Linear shrinkage (%)	Av. linear shrinkage (%)	Porosity (%)	Av. porosity (%)
1	1100	10	4.06		38.00	
2	1100	"	4.69	4.38	37.72	37.86
3	1150	"	8.78		22.81	
4	1150	"	8.52	8.65	23.50	23.16
7	1200	"	12.65		0.50	
8	1200	"	12.04	12.35	0.57	0.54
11	1250	"	13.24		0.00	
12	1250	"	13.65	13.45	0.00	0.00
15	1300	"	12.83		0.00	
16	1300	"	12.53	12.68	0.00	0.00
17	1100	100	7.33		33.49	
18	1100	"	6.68	7.01	33.96	33.73
19	1150	"	11.38		8.78	
20	1150	"	10.41	10.90		8.78
23	1180	"	13.54		0.00	
24	1180	"	13.11	13.33	0.00	0.00
25	1200	"	13.54		0.00	
26	1200	"	13.50	13.52	0.00	0.00
29	1260	"	13.29		0.00	
30	1260	"	13.44	13.37	0.00	0.00
31	1275	"	12.98			
32	1275	"	12.70	12.84		
34	1290	"	12.30		0.00	
35	1290	"	12.02	12.16	0.00	0.00
36	1045	1000	2.46		41.91	
37	1045	"	1.83	2.15	43.23	42.57
38	1105	"	6.98		25.74	
39	1105	"	8.54	7.76	23.76	24.75
40	1150	"	12.37		0.84	
41	1150	"	12.86	12.62	0.06	0.45
42	1175	"	13.28		0.00	
43	1175	"	13.13	13.21		0.00
57	1225	"	13.52		0.00	
58	1225	"	13.70	13.61	0.00	0.00
46	1275	"	13.24		0.00	
47	1275	"	13.20	13.22	0.00	0.00
54	1050	10,000	5.50		43.69	
55	1050	"	5.50	5.50	43.91	43.80
56	1120	"	12.83		6.04	
59	1120	"	12.83	12.83	5.85	5.95

X. Results

The shrinkage and porosity values are given in Tables I to VI. The values from the preceding tables are plotted in Figs. 4 to 9. It will

be noticed that the curves do not all pass through their corresponding points. This is due to the fact that they are cross-faired to give the best representative set of curves. While the deviation of many points is

TABLE VI

PARIAN BODY, No. 6

Specimen No.	Temp. (deg.)	Time (min.)	Linear shrinkage (%)	Av. linear shrinkage (%)	Porosity (%)	Av. porosity (%)
1	1100	10	5.69		32.02	
2	1100	"	5.53	5.61		32.02
3	1150	"	8.89			
4	1150	"	8.84	8.87	12.09	12.09
7	1200	"	10.57			
8	1200	"	10.25	10.41	1.27	1.27
11	1250	"	10.57		0.00	
12	1250	"	10.66	10.62	0.00	0.00
15	1300	"	9.90		0.00	
16	1300	"	9.90	9.90	0.00	0.00
17	1100	100	6.93			
18	1100	"	6.70	6.82	22.56	22.56
19	1150	"	9.33		3.17	
20	1150	"	9.50	9.42	3.57	3.37
23	1180	"	11.47		0.00	
24	1180	"	10.79	11.13	0.00	0.00
25	1200	"	11.11		0.00	
26	1200	"	11.16	11.14	0.00	0.00
29	1260	"	11.00			
30	1260	"	10.55	10.78		
31	1275	"	10.57			
32	1275	"	10.18			
33	1275	"	10.57	10.44		
34	1290	"	11.08		0.00	
35	1290	"	10.51	10.80	0.00	0.00
36	1045	1000	2.42		30.62	
37	1045	"	2.43	2.43	31.12	30.87
38	1105	"	8.35		14.36	
39	1105	"	8.15	8.25		14.36
40	1140	"	9.78		0.57	
41	1140	"	9.98	9.88	0.00	0.29
42	1175	"	11.16		0.00	
43	1175	"	11.36	11.26	0.00	0.00
57	1225	"	9.53			
58	1225	"	9.94	9.74		
48	1275	"	9.90			
49	1275	"	8.81	9.36		
54	1050	10,000	6.73		15.79	
55	1050	"	6.73	6.73		15.79
56	1120	"	10.16		0.00	
59	1120	"	10.10	10.13	0.00	0.00

large compared with the distance between curves, the location of the curves is believed to be substantially correct because of the consistency between the various bodies.

An examination of the preceding curves will show that the influence of

time is to shift each curve horizontally without alteration in shape. The curves are shifted approximately the same amount for each ten-fold increase in time, and the same shift occurs with the porosity curves as with the shrinkage curves. The shift in the curves, however, is not exactly the same for all of the bodies. This shift for each ten-fold increase in time is given below:

Body	Shift in °C
1	25
2	22
3	32
4	35
5	23
6	20
Av.	26.2

It will be noticed that the earthenware bodies have the greatest value and the Parian, or most glassy body, the least. In Fig. 10 are plotted the maturing temperatures against time on semi-log paper. The earthenware was considered mature at 8% porosity and the vitreous ware was mature when the porosity was zero.

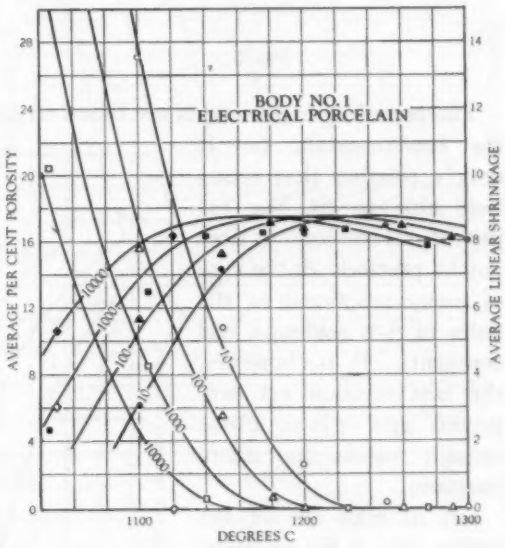


FIG. 4.

The appearance of the fired bodies for similar porosities, but different firing times, is much alike. The rapidly-fired vitreous bodies, however, showed signs of blistering beyond the point of zero porosity. Evidently a certain length of time is needed to allow the air in the body to escape before the pores are closed. Probably a slow heating-up would be more valuable than a long soaking period. This blistering seems to be the limiting factor in rapid firing of vitreous ware. Earthenware presents no such limit. As will be shown in the second part of this paper, the time of firing has a considerable effect on the crystal structure.

As the maturing of a body is really a chemical reaction approaching an equilibrium condition, we might expect that it would follow the usual laws.

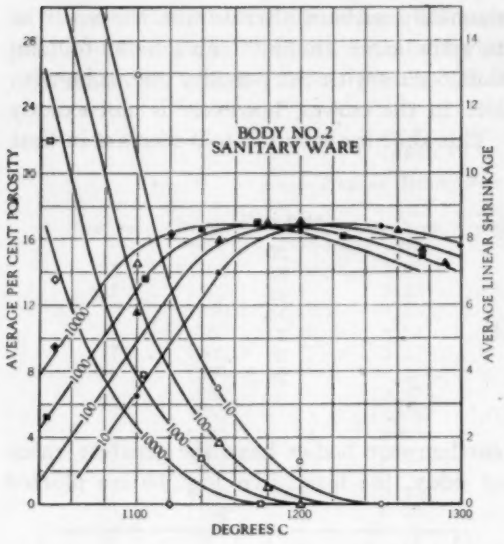


FIG. 5.

In general, an alkaline glass formed from the feldspar dissolves the clay and part of the quartz, and in some cases throws out mullite crystals. It has been found that the influence of temperature on the velocity of irreversible reactions is closely expressed by the following empirical equation of Arrhenius:[4]

$$\text{Log}\,\frac{k_{t_2}}{k_{t_1}} = A\left(\frac{1}{T_1} - \frac{1}{T_2}\right),$$

where k_{t_1} is the reaction velocity at temp. T_1 (°C absolute)

k_{t_2} is the reaction velocity at temp. T_2 (°C absolute)

A is a constant of the reaction.

The preceding expression is not based on any theoretical derivation from the fundamentals, but is only a relation that seems best able to fit the experimental results. It does not fit precisely in the case of many reactions; so the value of A is seldom a real constant. It is, however, the best relation yet proposed and gives close enough values for many purposes.

Let us take one of the bodies, No. 5 for example, and examine how closely its values follow the above equation. The calculations are given in the following table:

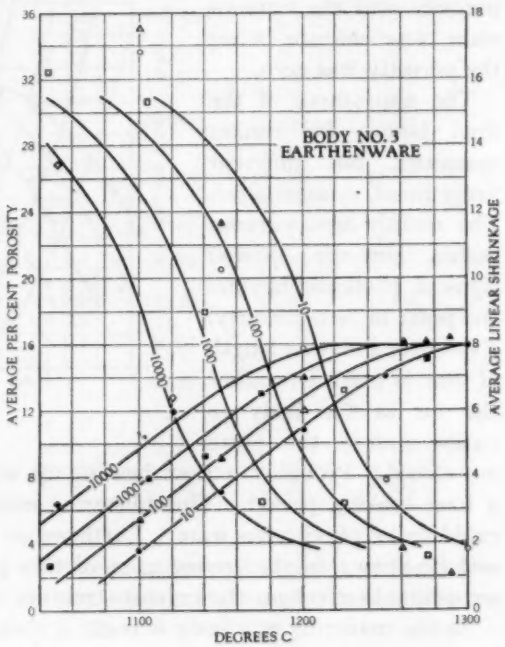


FIG. 6.

[4] *Z. physik. Chem.*, **4**, 226 (1889).

Rate of reaction	$\frac{1}{10{,}000}$	$\frac{1}{1000}$	$\frac{1}{100}$	$\frac{1}{10}$
Maturing temp., °C	1155	1178	1200	1222
Maturing temp., abs.	1428	1451	1473	1495
$\frac{1}{T}$	0.007003	0.006890	0.006789	0.006689
$\frac{1}{T_1} - \frac{1}{T_n}$		0.00111	0.00218	0.00322
$\text{Log}\frac{k_{t_n}}{k_{t_1}}$		1	2	3
A		1110	1090	1070

This indicates that A is constant well within the error of experiment. Therefore, the preceding equation expresses the relation between time and temperature for this body. Of course, other expressions could be used to fit this data equally well; for example:

$$\text{Log } K = BT$$

where K is the reaction rate and B a constant.

As the first expression, however, is found to be more generally applicable, it is probably the most satisfactory. The value of A is different for the other bodies, but in each case it is substantially a constant. The values are as follows:

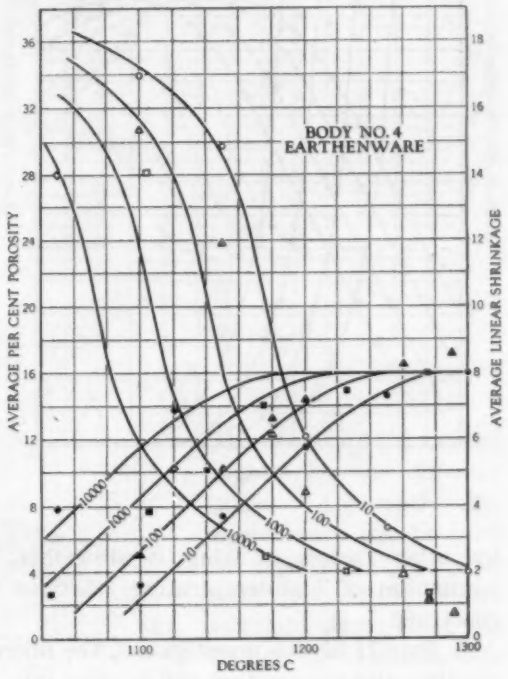


FIG. 7.

Body	1	2	3	4	5	6
A (av.)	1155	1020	1420	1550	1090	950

This relation enables one to determine the correct temperature for any firing time if the conditions are known for one temperature. In making these calculations some caution is necessary as the temperature conditions of the ware in a commercial kiln are seldom the conditions measured with the pyrometer. Again it must not be attempted to measure temperatures with cones, for they too are affected in a manner like the bodies.

At first sight it seems rather remarkable that an increase of only 20 to 30°C in temperature accelerates the reaction rate ten-fold. This may be due to the fact that the temperature influences several factors entering into the reaction. These individual changes may be small but when multiplied together are large. One of the individual factors is the viscosity of the glass formed. We should expect the reaction to be influenced inversely as the viscosity. The table below gives an idea of the viscosity change in a typical glass:

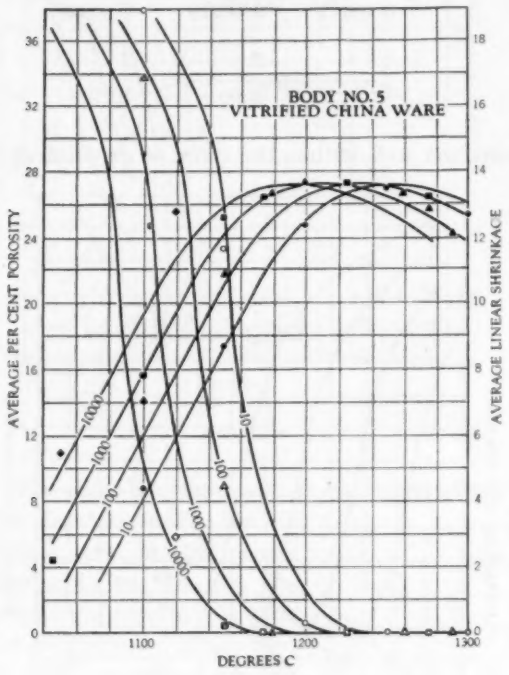


FIG. 8.

Temp.	Log Viscosity of Glass
1100°C	3.5
1150	3.2
1200	3.0
1250	2.8
1300	2.7

It can be seen that the viscosity change is not more than a few per cent of the total required. This means that the reaction velocity between the glass, clay, and quartz must be greatly influenced by other factors. Taking it altogether little is known about the mechanism of high-temperature reactions where glasses and slags are concerned.

In Part II of this investigation, the microstructure and its relation to the time and temperature will be gone into completely.

XI. Recommendations for Further Work

It would be desirable to take a single body and repeat the foregoing tests with larger specimens and a closer temperature control. A number of specimens should be run at each condition in order to give a precise average. Runs of 100,000 minutes' duration would also be of great value. This would enable one to obtain a closer evaluation of the time-temperature relation than was possible here. It would also be desirable to fire some larger pieces, such as plates, on various schedules and then subject them to

the usual physical tests such as shock tests, resistance to heating and cooling, and electrical resistivity.

The values of A for other ceramic materials, such as raw clays, refractory materials, pyrometric cones, glazes, etc., would be of interest, especially if A was found to be a constant as in the case of whiteware.

XII. Conclusions

It may be concluded from the preceding results that the relation between the time and temperature effect on the rate of reaction can be expressed by:

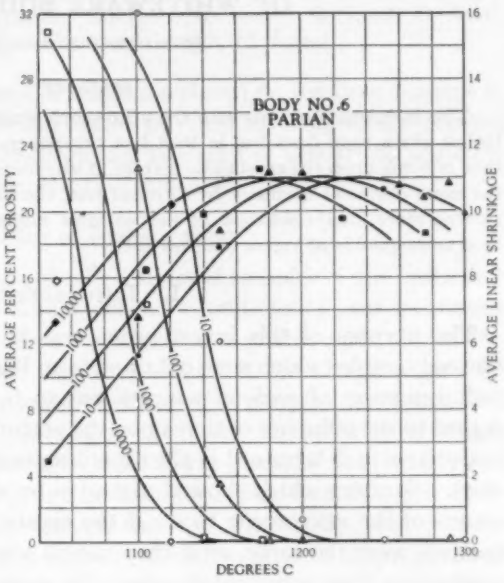


FIG. 9.

$$\text{Log}\ \frac{k_{l_2}}{k_{l_1}} = A\left(\frac{1}{T_1} - \frac{1}{T_2}\right).$$

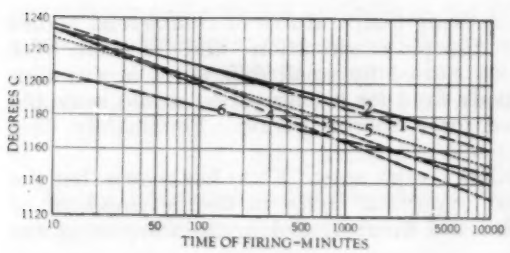


FIG. 10.

The constant A varies slightly for the different bodies. Apparently the earthenware can be fired as rapidly as the kiln will permit but the vitrified ware must be brought up slowly enough to prevent blisters.

Acknowledgment The authors wish to express their appreciation for the excellent cooperation from several members of the whiteware industry, and particularly to A. V. Bleininger for pointing out the importance of this subject.

THE INFLUENCE OF TIME ON THE MATURING TEMPERATURE OF WHITEWARE BODIES. II.[1]

By Charles L. Norton, Jr.[2]

ABSTRACT

This investigation deals with the microscopic examination of three of the whiteware bodies which were described in Part I of this paper. With respect to the influence of time of firing upon the crystalline texture, it was found that with samples which showed the same degree of maturity by physical test, the long-fired, low-temperature samples showed more quartz solution as well as more mullite development than the samples fired more quickly at higher temperatures.

I. Introduction

The purpose of this investigation was to study the microstructure of various samples which were obtained from Part I of this article. The crystalline texture of various samples was to be determined with particular regard to the influence of time upon the maturing conditions. The point of maturity was determined in the experiments in Part I by means of physical tests. Samples which showed maturity by these tests were examined by means of the microscope to see if the crystal structures of these matured samples were the same, or if they varied among themselves. Several investigators have commented previously upon the time factor in maturing, but no systematic data seem to have been collected on this subject. The large number of samples, however, which were obtained in Part I of this investigation presented an unusual opportunity to study this matter.

A. A. Klein[3] reports that "the firing temperatures of commercial bodies were predicted from their microscopic examination" and "if there were great differences in constitution caused by small differences in duration of firing, a low-temperature body fired for a long period would resemble a high-temperature body fired for a shorter period. Fortunately, this is not the case."

H. Insley[4] in referring to Klein's work says, "Klein has shown that the firing temperature is the most important factor in the development of mullite needles, both as to size and number, and in the solution of the quartz grains."

A. B. Peck,[5] however, states in his summary that "the longer the firing at a constant temperature, the greater is the amount of sillimanite formed, the larger and better developed do the crystals become, and the greater is

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received December 1, 1930.

[2] Research Associate, Massachusetts Institute of Technology, Cambridge, Mass.

[3] A. A. Klein, Bur. of Standards, *Tech. Paper*, No. 80.

[4] H. Insley, "Microstructure of Earthenware," *Jour. Amer. Ceram. Soc.*, **10** [5], 317 (1927).

[5] A. B. Peck, "Effect of Time and Temperature on the Microstructure of Porcelain," *ibid.*, **2**, 175 (1919).

the amount of quartz dissolved." Also, "in view of all the preceding facts it does not appear that the temperature of firing of porcelain bodies can be predicted from a petrographic microscopic study without at least some knowledge of the composition and length of firing."

In view of the different degree of emphasis placed on the time element in the crystalline texture of porcelain bodies by these investigators, it seemed of value to examine the samples produced in Part I of this article to determine the effect of time upon the crystal structure.

II. Plan of Investigation

The plan of investigation was to take a series of samples of one particular body which showed maturity under various conditions of heat treatment and examine the resulting texture by means of a microscope. From the examination of the temperature curves in Part I it was thought that the vitrified ware which matured when reaching 0% porosity gave the best samples. The point of 0% porosity is the point of maturity to which these bodies are fired commercially, and it was thought that this point would be the most interesting one to examine. For instance, for Body No. 1, an electrical porcelain, points on the 10-, 100-, 1000-, and 10,000-minute curves which showed 0% porosity would be taken. The individual samples would then be taken, which corresponded with these four points of 0% porosity, and this would give four samples. Likewise, No. 2, a sanitary body, and No. 6, a Parian body, were chosen. The earthenware, Nos. 3 and 4, which mature at about 8% porosity, were not taken since suitable samples were not available at the point of maturity. Number 5, a vitrified chinaware, was not suitable on account of the thorough ball milling which the original mixture received. Bodies No. 1, No. 2, and No. 6 were consequently taken and examined according to this scheme.

III. Method of Investigation

The methods employed consisted of the usual petrographic examination, using the polarizing microscope. Thin sections of all the samples were prepared and powder immersion mounts were made whenever necessary. The powder immersion mounts were only used to determine some constituent which was not readily recognized in the thin section. The thin sections, on the whole, give a much better picture of the structure. These thin sections were prepared in the laboratory in order to obtain the same thickness for all the sections in the series for purposes of comparison.

The photomicrographs which accompany this paper presented some difficulty. It was thought advisable to take the whole series of photomicrographs at the same magnification for purposes of comparison. It was difficult to decide upon one magnification which was exactly suitable for all the samples, and the result was, of necessity, in the nature of a compro-

mise. Six hundred and fifty diameters were finally selected, as it was the minimum magnification which would show the minute mullite crystals in any detail. It was also thought advisable to take these photomicrographs with polarized light. If crossed-nicols alone were used it would show up the detail of the quartz grains, but it would fail to render any detail in the glassy areas. Consequently, a gypsum plate was used in conjunction with the crossed-nicols. This renders the whole field red of the first order, the glassy areas can be examined in detail, and at the same time the bire-

FIG. 1.—Body No. 1, Sample No. 3, 9% porosity, 10 minutes at 1150°C.

fringent quartz grains can be clearly distinguished. Accordingly, all of of the photomicrographs were taken at 650 diameters with crossed-nicols and the gypsum plate which gives first order red. A Leitz (No. 7) 3 mm. dry achromatic objective used in conjunction with a 12× periplanatic ocular and a camera extension of 250 mm. gave this magnification when used with the slightly negative lens which is contained in the analyzing prism in the polarizing microscope.

IV. Results of Examination

Body No. 1. Electrical Porcelain

Kaolin	20.6%
Ball clay	26.0
Flint	18.6
Feldspar	34.8

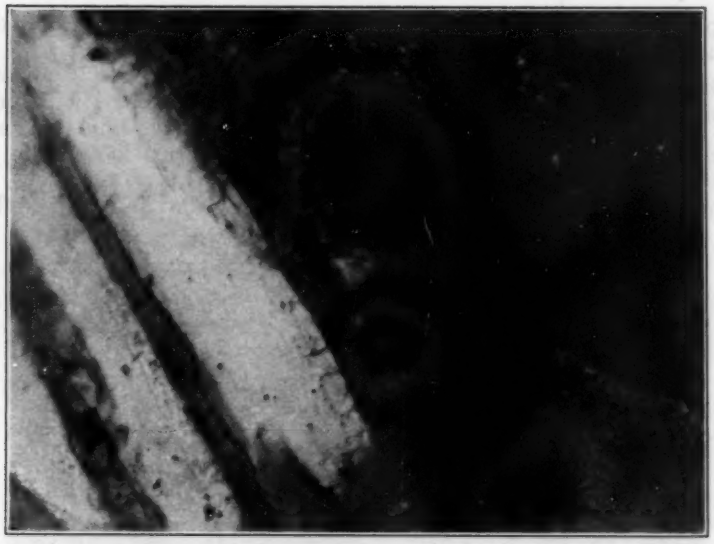


FIG. 2.—Body No. 1, Sample No. 11, 0% porosity, 10 minutes at 1250°C.

(1) Sample No. 3, 9% porosity, 10 min. at 1150°C This structure has not matured, showing 9% porosity. The quartz grains show no signs of solution and the feldspar has been only partially melted. In Fig. 1 in the center, a grain of feldspar can be seen which has been partially melted and has left an island of unmelted

FIG. 3.—Body No. 1, Sample No. 24, 0% porosity, 100 minutes at 1200°C.

feldspar in the middle. The unmelted portion shows typical feldspar twinning. Several quartz grains are seen in the field.

(2) Sample No. 11, 0% porosity, 10 min. at 1250°C This structure shows practically all of the feldspar to have been melted with only a few grains which show unmelted areas. Figure 2 shows one of such large feldspar grains which has not been totally melted. The quartz gives no signs of solution at the edges, even on the smallest grains. The melted feldspar grains have not diffused

FIG. 4.—Body No. 1, Sample No. 43, 0% porosity, 1000 minutes at 1175°C.

into the body, but remain as an isotropic mass which retains the outline of the original grain.

(3) Sample No. 24, 0% porosity, 100 min. at 1200°C The quartz grains in this structure still maintain their sharp corners even on the smallest grains and do not show signs of solution. The large feldspar grains still maintain their original outline and the ground mass is more homogeneous than in No. 11. There is no mullite crystallization.

(4) Sample No. 43, 0% porosity, 1000 min. at 1175°C This sample shows a slight solution of the quartz grains, and there are needle crystals of mullite which are embedded in the pseudomorph of the original feldspar grains. It can be seen from Fig. 4 that these crystals are all contained in the interior of the grain which possesses sharp outlines, and that these needles have not grown from the outside and pierced through borders of the grain. There is more glassy material in the structure than in No. 24, and it is more translucent for that reason.

FIG. 5.—Body No. 1, Sample No. 53, 0% porosity, 10,000 minutes at 1120°C.

(5) Sample No. 53, 0% porosity, 10,000 min. at 1120°C This structure is similar to No. 43 except that the quartz has just a trace more solution, although the total quartz solution is small, and that the mullite crystals are smaller but

FIG. 6.—Body No. 2, Sample No. 15, 0% porosity, 10 minutes at 1250°C.

more numerous, giving an intergrown structure. The mullite crystals occur as in No. 43, with the exception of size.

Body No. 2. Sanitary Porcelain	
Kaolin	24.5%
Ball clay	25.5
Flint	24.0
Feldspar	25.5
Whiting	0.5

(6) Sample No. 15, 0% porosity, 10 min. at 1250°C This structure shows no signs of quartz solution, even the smallest grains showing sharp corners. The feldspar has all melted, but the large grains have kept their original outline. There is no sign of mullite crystallization.

FIG. 7.—Body No. 2, Sample No. 31, 0% porosity, 100 minutes at 1200°C.

(7) Sample No. 31, 0% porosity, 100 min. at 1200°C This structure is almost identical with that of No. 15. There is no quartz solution or development of mullite crystals.

(8) Sample No. 47, 0% porosity, 1000 min. at 1175°C In this sample there is little quartz solution and mullite development in the pseudomorph of the feldspar grains. Figure 8 shows in the center of the photograph a grain which is evenly embedded with needle crystals. It can be seen here that these needles are all contained in the outline of the original grain and that the outline itself is sharp. Two quartz grains are shown which give very small traces of solution.

(9) Sample No. 55, 0% porosity, 10,000 min. at 1120°C This structure shows more quartz solution than No. 47. The grains, particularly the smaller ones, show a recog-

FIG. 8.—Body No. 2, Sample No. 47, 0% porosity, 1000 minutes at 1175°C.

nizable rounding, although the larger ones show very little. The mullite in this specimen occurs the same as in No. 47; the size of the needles is much smaller, however, and they are much more intergrown. Figure 9 shows two such grains. The crystals do not stand out as clearly as in

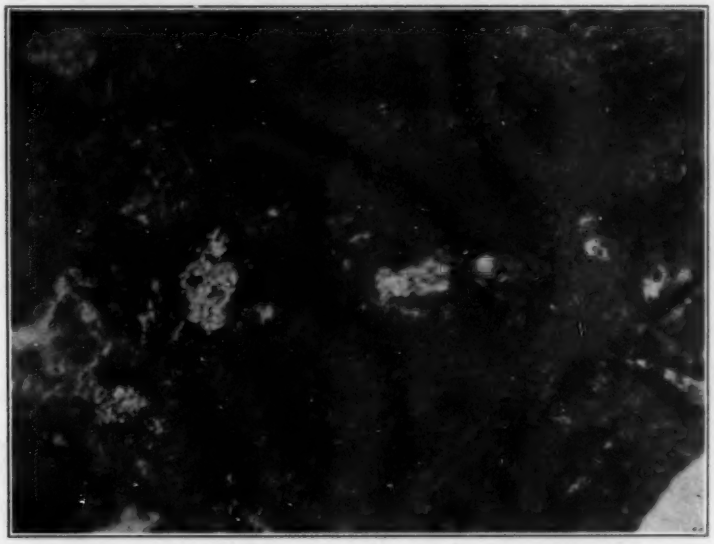


FIG. 9.—Body No. 2, Sample No. 55, 0% porosity, 10,000 minutes at 1120°C.

Fig. 8, due to their intergrown character. The sharp outlines of the two grains can be seen, however.

Body No. 6. Parian Body	
Kaolin	30%
Ball clay	10
Feldspar	60

(10) Sample No. 8, 1.27% porosity, 10 min. at 1200°C This sample is not quite matured, having a porosity of 1.27%. The quartz (contained as impurity in the feldspar) shows no signs of solution. The feldspar has not all melted, particularly in the larger grains, and there is no mullite development. Figure 10 shows a

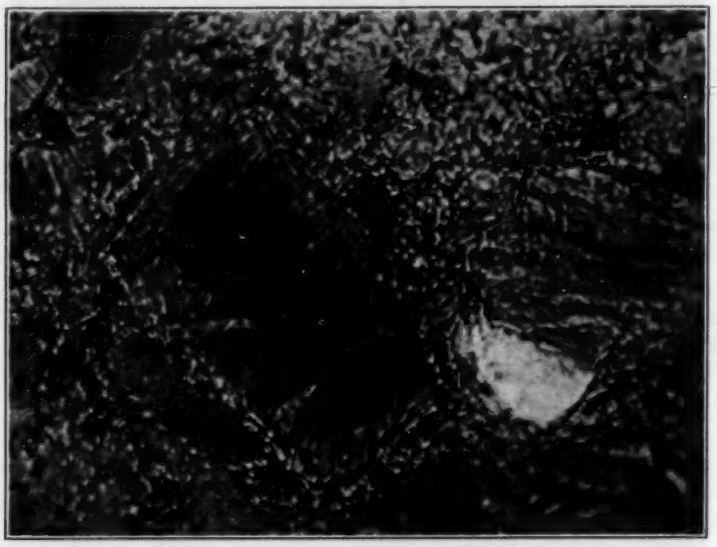


FIG. 10.—Body No. 6, Sample No. 8, 1.27% porosity, 10 minutes at 1200°C.

partially melted feldspar grain in the center with a few quartz grains in the field.

(11) Sample No. 12, 0% porosity, 10 min. at 1250°C This sample is slightly below the porosity curve. The section shows the quartz to be undissolved and even the smallest grains have sharp corners. The two central grains in the photograph are quartz. The feldspar has all melted, although the original outline of the grains is intact. There is no mullite development.

(12) Sample No. 23, 0% porosity, 100 min. at 1180°C This structure is exactly on the porosity curve, and is almost the same as No. 12. Figure 12 shows a large triangular grain of quartz, which shows no solution, and several feldspar grains which have turned to an isotropic glass, but which still retain their original outline. There is no mullite development.

FIG. 11.—Body No. 6, Sample No. 12, 0% porosity, 10 minutes at 1250°C.

(13) Sample No. 41, 0.29% porosity, 1000 min. at 1140°C This sample is a trifle above the maturity point of 0% porosity, and the texture is nearly identical with No. 23. Figure 13 shows one large quartz grain and several glassy feldspar grains. There is no noticeable mullite development.

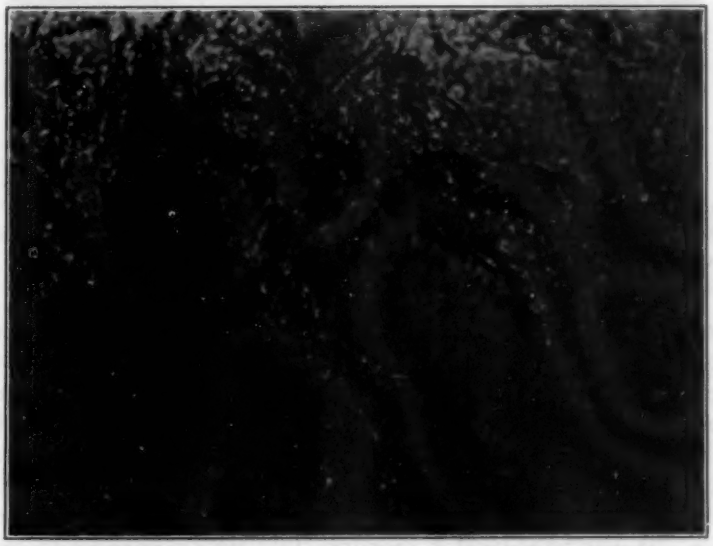


FIG. 12.—Body No. 6, Sample No. 23, 0% porosity, 100 minutes at 1180°C.

(14) Sample No. 43, 0% porosity, 1000 min. at 1175°C This structure is slightly below the porosity curve. The structure is much the same as No. 41, showing practically no quartz solution. The feldspar grains can be seen to have retained their outline, and there are extremely minute needle crystals showing in some of these grains. They are too small to show in the photomicrograph even at 650 diameters.

(15) Sample No. 56, 0% porosity, 10,000 min. at 1120°C The quartz in this structure shows some solution, particularly on the smaller grains. The feldspar grains show a much more evident mullite development than in No. 43. Figure 15 shows one of these grains, and the needle crystals which appear to be evenly distributed and which stop sharply at the grain outline can be seen clearly.

FIG. 13.—Body No. 6, Sample No. 41, 0.29% porosity, 1000 minutes at 1140°C.

V. Discussion of Results

From these results it is evident that a gradual change occurs from the short-time, high-temperature firings to the long-time, low-temperature firings. The quartz solution and mullite development in each case is greater in the long-time runs than in the short ones. It has been shown that a sample fired for 10,000 minutes has more quartz solution and mullite development than one fired for 10 minutes, although the temperature of the long-fired sample was 130°C lower than the short-fired sample. It may be concluded, therefore, that time is an important factor in the final crystalline texture.

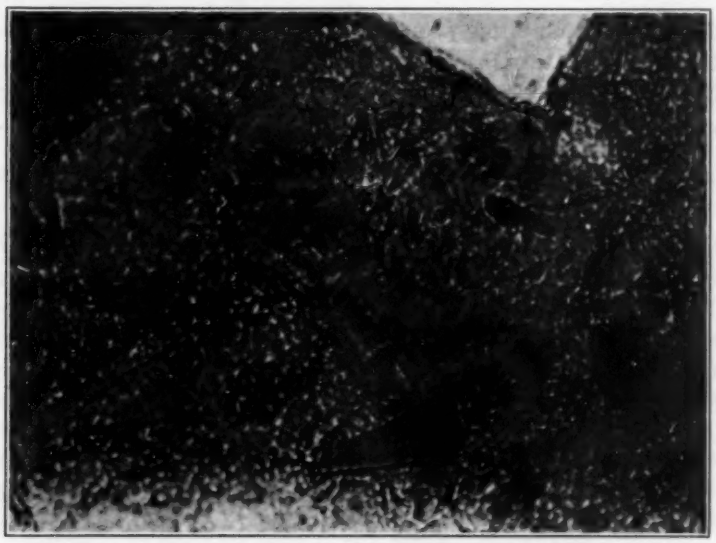


FIG. 14.—Body No. 6, Sample No. 43, 0% porosity, 1000 minutes at 1175°C.

Differences in crystalline texture in turn make physical differences in the ware, such variations being in translucency, resistance to thermal shock, mechanical strength, and electrical insulating values. It would be necessary, therefore, to know to what service a ware is to be subjected, before

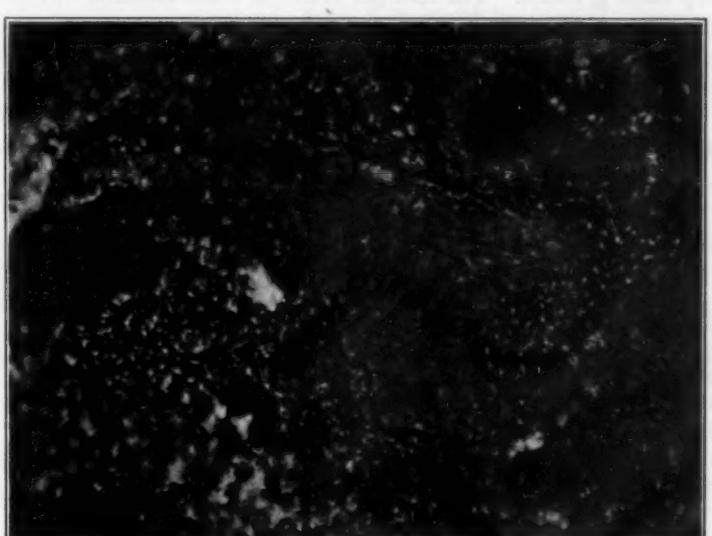


FIG. 15.—Body No. 6, Sample No. 56, 0% porosity, 10,000 minutes at 1120°C.

deciding upon what firing schedule will be the most satisfactory. The most economical rate of firing will, of course, be the most rapid one but may not be the most practical one to follow. A structure practical for sanitary body No. 2 might be different from a desirable structure for the No. 1 electrical porcelain.

VI. Mechanism of Mullite Formation

There has been some discussion concerning the mechanism of mullite formation in porcelain bodies. It is generally believed that the process consists of the gradual breakdown of the clay material, which has the approximate formula of $Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$, under the influence of the melted feldspar ($K_2O \cdot Al_2O_3 \cdot 6SiO_2$ for potash feldspar) to form first amorphous mullite ($3Al_2O_3 \cdot 2SiO_2$) and silica glass. As the reaction continues, the amorphous mullite particles grow to a size where individual crystals may be resolved under a high-power objective and finally grow to such a size that the optical properties may be measured. It has been assumed that the first traces of mullite development occur, therefore, at the edges of the clay particle where it comes in contact with the feldspar glass. Kaolin, when heated alone, acts in a similar way, but when heated alone it requires a much higher temperature. Large mullite crystals can be developed in melted kaolin without the use of any flux.

The source of mullite crystals in a porcelain is undoubtedly the clay since it is the only constituent which contains a sufficient amount of alumina to develop these crystals. The feldspar contains some alumina but has only one molecule of alumina for six molecules of silica. There seems to be sufficient evidence, however, for believing that the first mullite development does not occur in the clay grains themselves.

A. S. Watts[6] notes that on some of his medium-fired experimental bodies there is a structure which has very angular quartz grains and "more or less circular particles of the larger feldspar grains, each of which is filled with fine sillimanite needles." He does not enlarge upon this statement, however.

A. B. Peck[7] says that two distinct types of sillimanite development occur in a porcelain body.

> (1) The sillimanite shows a fibrous appearance brought about by long slender crystals orienting themselves parallel to one another, or small amorphous-like grains. These formed inside the outline of the original clay grain, although the corners are rounded. (2) Definite well-formed crystals embedded in the feldspar glass. These occur in high-fired or high feldspar bodies, or in long-fired, medium-temperature bodies.

---

[6] A. S. Watts, "Progress of Vitrification and Solution in Some Porcelain Mixtures," *Jour. Amer. Ceram. Soc.*, **2**, 400 (1919).

[7] See footnote 5.

H. M. Kraner[8] says that in "porcelain and vitrified chinaware only the small feldspar grains go into solution; the large grains remain and do not lose original contour....." "Mullite needles penetrate the original grain which has retained its original shape....." "The distance of penetration from the outside is shallow."

Nearly every other investigator speaks of the cloudy appearance of the ground mass due to submicroscopic crystals of mullite in the clay grains, and their later growth to sizes which can be resolved in the microscope.

In these specimens the mullite crystals all seem to have developed from inside the outline of the original feldspar grains. These crystals do not extend beyond the outlines of the original feldspar grain, and this can be seen particularly in Figs, 4, 8, and 15. This does not agree with Kraner's observation that needles pierce the grain from the outside. Likewise, it can be seen that the same photographs show a fairly even distribution of needle crystals within the grain, which is not in agreement with the shallow penetration spoken of by Kraner. He mentions large grains, however, and these large grains may have been much larger than any encountered by the author. This might explain the differences in observation.

This same mode of occurrence and development of mullite crystals was observed in all three of the bodies investigated. In none of the sections examined was there a general indiscriminate occurrence of mullite, but always in the area bounded by the outline of the feldspar pseudomorph.

The cause of the formation of mullite in this way is difficult to understand. The feldspar does not contain, by far, enough Al_2O_3 to cause appreciable mullite development, even if it could be formed. Various investigators have fused feldspar and allowed it to cool slowly to ascertain whether any devitrification took place on cooling. Bowen[9] has formed leucite from feldspar, but no mullite has been recorded as being found. In the present investigation, feldspar was heated for 1000 minutes at 1230°C and cooled at the same rate as the porcelain samples. The resulting structure showed only the quartz crystals which occurred as impurity in the feldspar and a clear glass which contained no mullite crystals. The most logical explanation would seem to be that some sort of slow diffusion goes on which makes the feldspar glass sufficiently rich in alumina so that mullite crystallizes out. The exact mechanism of this would seem to be very complicated and more work must be done before the problem can be settled.

VII. Conclusions

From the results of examinations of these vitrified bodies we may come to the following conclusions:

[8] H. M. Kraner, "Importance of Glass Phase in Porcelain," *Jour. Amer. Ceram Soc.*, **12** [6], 383 (1929).

[9] *Amer. Jour. Sci.*, CCIV, p. 1 (1922).

The time factor is one which is certainly of importance in the maturing of whiteware.

The crystalline texture of bodies receiving a short-time, high-temperature firing is different from that of a long-time, low-temperature firing, even though the heat treatment is such as to give both bodies the same degree of maturity by physical tests. The crystalline texture of the bodies receiving a long-time, low-temperature firing shows more quartz solution and more mullite development than the bodies which have received a short-time, high-temperature firing.

The first development of mullite crystals in vitrified ware which has the usual commercial degree of maturity, takes place in the feldspar grains. These grains have not lost the pseudomorphic outline of the original feldspar grain, but have relatively sharp outlines. The mullite needles in the interior of the grains do not extend beyond this outline. As the needle crystals become more numerous they decrease in size to form an interlocking, intergrown mass.

EFFECTS OF AUTOCLAVE TREATMENTS ON CERAMIC BODIES AND CLAYS[1]

By H. H. Holscher[2]

ABSTRACT

It has been found that porous ceramic bodies increase in volume and weight due to an autoclave treatment in which the ware is subjected to steam at a pressure of 150 pounds per square inch. The change is rapid at first but decreases as the time of treatment is increased. Typical American and English china clays also increase in volume but ball clays when fired to the same temperature as the china clays do not increase in volume. The effect of prolonged drying treatments after the autoclave treatment is also studied. Data given indicate that the changes in volume are not necessarily caused by rehydration of the clay within the body. Bodies containing clay, feldspar, and flint show a greater increase in volume than do the pure clay constituents. It is shown that the composition is a more important factor than absorption in determining the reaction of ceramic products to the autoclave treatments.

I. Introduction

Crazing of glazed ceramic products may be divided into two distinct classes: (1) that which appears during the cooling of the kiln or immediately thereafter, and (2) that which appears weeks, months, or years after the ware has been fired. "Immediate" crazing of the first class is generally believed to be caused by a difference in the thermal expansions of a body and glaze, especially when the glaze is not sufficiently strong or elastic to withstandt he stresses produced by these differential expansions. Formerly it was a common belief that "delayed" crazing of the second class originated from strains in the glaze which were not sufficient to cause crazing when the ware was removed from the kiln but might be caused by thermal or mechanical shock in service. It is known that porous ceramic ware stored in New Orleans, Galveston, and San Francisco are more subject to "delayed" crazing than similar ware stored in Denver, St. Paul, and cities of the northern states. The theory has been advanced[3] that the body expands while in service or storage, and that the glaze does not expand and the ultimate result is the failure of the glaze, or crazing. Another factor

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received October 9, 1930.

Most of the material here reported was presented as a thesis to the Graduate School, Ohio State University, June, 1929, in partial fulfilment for the degree of M. S. in Ceramic Engineering. More complete details and data on this investigation may be secured from a forthcoming bulletin of the Engineering Experiment Station, Ohio State University, Columbus, Ohio.

[2] Coöperative fellow in Ceramic Engineering, Engineering Experiment Station, Ohio State University.

[3] H. G. Schurecht, "Testing Crazing of Glazes Caused by Increases in Size of Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **11** [5], 271 (1928).

which must not be overlooked is the possible "after working"[4] of the glass which makes up the glaze, usually resulting in contraction.

Several methods have been used to determine the resistance of various body and glaze combinations to crazing,[5] but only recently was a test proposed that parallels "delayed" crazing. Schurecht[3] proposed that glazed specimens be subjected to a steam pressure of 150 to 175 pounds per square inch for one hour and presented data to show that the test gave results that paralleled weathering. This test has since been widely adopted in the terra cotta industry and in some instances in the whiteware and wall-tile industries. It is a test proposed for more or less porous bodies since it has been found that vitreous bodies are not appreciably susceptible to crazing by this treatment. In two subsequent papers Schurecht[6] has presented more data upon the test and other data upon the test have been presented by Wright[7] and by Everhart.[8] It must be mentioned that Merritt and Peters[9] pointed out discrepancies in the thermal expansions of body materials under a first and second heating.

II. Experimental Methods

Changes in length of the bodies were measured by means of two horizontally mounted micrometer microscopes in which the smallest division, as determined by comparing with a standardized Invar meter bar, was 0.0024 mm. long. Reference marks on the glazed bars consisted of small crosses approximately 14.7 cm. apart made by a diamond point on the glazed surface. The standard Invar bar was used as a reference for keeping the zero points of the micrometer microscopes a definite distance apart. Throughout the course of the work it was found that the experimental

[4] Hovestadt, Jena Glass and Its Scientific and Industrial Applications, pp. 239–318 (1902), Macmillan Co., 66 Fifth Ave., New York, N. Y.

H. V. E. M. Renn, "Sources of Error in Glass Volumetric Apparatus," *Jour. Amer. Ceram. Soc.*, 9 [12], 857 (1926).

[5] E. C. Stover, "Delayed Crazing and Shivering," *Trans. Amer. Ceram. Soc.*, **11**, 89 (1909); H. E. Ashley, "The Testing of Raw Materials for a Whiteware Pottery," *ibid.*, **9**, 61 (1907); J. W. Cobb, "Note on Disintegration by Crystallization and Freezing," *ibid.*, **11**, 65 (1909); H. Harkort, "A Method of Testing Crazing of White Ware," *ibid.*, **15**, 368 (1913); F. K. Pence, "Crazing Test for Wall Tile," *ibid.*, **18**, 622 (1916).

[6] H. G. Schurecht and G. R. Pole, "Effect of Water in Expanding Ceramic Bodies of Different Compositions," *Jour. Amer. Ceram. Soc.*, **12** [9], 596 (1929) and Bur. of Standards, *Jour. Research*, **3**, 331 (1929); H. G. Schurecht and G. R. Pole, "Method of Measuring Strains between Glazes and Ceramic Bodies," *Jour. Amer. Ceram. Soc.*, **13** [6], 369 (1930), and Bur. of Standards, *Jour. Research*, **5**, 97 (1930).

[7] E. P. Wright, "A Study of the Absorption of Two Earthenware Bodies and Their Resistance to Crazing in the Steam Test," *Jour. Amer. Ceram. Soc.*, **12** [2], 118 (1929).

[8] J. O. Everhart, "Simulative Service Tests for Glazed Building Materials," *ibid.*, **13** [6], 404 (1930); also O. S. U., Eng. Expt. Sta., *Circ.*, No. 18.

[9] G. E. Merritt and C. G. Peters, "Interferometer Measurements of the Thermal Dilatation of Glazed Ware," *Jour. Amer. Ceram. Soc.*, 9 [6], 332 (1926).

error in length measurements was approximately 0.01% expressed in per cent length of the bar. Thus if a bar is reported to have a length change of 0.113%, this is considered to be 0.113% ± 0.01%. The room in which the measurements were made had only one narrow outside wall and during the winter (when practically all the measurements were made) its temperature was controlled by an automatic thermostat making thermal expansion corrections unnecessary.

III. Results on Experimental Bodies

(1) Effect of Repeated Autoclave Treatments

To study volume and weight changes due to repeated autoclave treatments, bars were made of a semivitreous body (blunged and filter-pressed in the usual manner) of the following composition:

Body No. 1	Per cent
Buckingham feldspar	14
Flint	34
MWM English china clay	29
Florida kaolin	8
Tenn. ball clay No. 7	15

Bars used for weight determinations were approximately 1 x 1 x 3 inches, while those used for length changes were 1 x 1 x 7 inches. The same bars could not be used for both determinations since the length change bars could not be made shorter and they were too heavy to be weighed on the analytical balances available. These bars were fired to cone 5+ and the long bars glazed (on one side at the extreme ends) for reference marks. The glaze used was a commercial whiteware glaze maturing at about cone 4. The changes in length and weight of these bars were determined after each of six successive autoclave treatments (one hour at 150 pounds per square inch). Before each measurement or weighing they were dried at

TABLE I

EFFECT OF REPEATED AUTOCLAVE TREATMENTS (BODY NO. 1)

	Per cent increase in length due to x treatments					
Bar No.	1	2	3	4	5	6
88	0.094	0.131	0.150	0.161	0.174	0.178
89	.084	.099	.118	.122	.142	.154
93	.066	.084	.107	.146	.157	.148
94	.114	.117	.132	.152	.164	.153
Av.	.089	.108	.127	.145	.159	.158
	Per cent increase in weight due to x treatments					
Bar No.	1	2	3	4	5	6
16	0.36	0.37	0.58	0.66	0.63	0.46
17	.29	.38	.47	.47	.55	.56
18	.25	.31	.36	.41	.46	.41
19	.31	.35	.56	.59	.54	.38
85	.31	.41	.38	.47	.49	.41
91	.30	.39	.37	.42	.51	.43
Av.	.30	.37	.45	.50	.53	.44

110°C for 24 hours. In the autoclave the bars were supported above the level of the water on a three-mesh wire screen. The values are given in Table I and the average length change plotted in Fig. 1. It is evident that there is a definite volume increase accompanied by an increase in weight due to the autoclave treatments. The increase per treatment is rapid at first but decreases after three treatments. If the drying conditions were closely controlled the data would probably follow a general parabolic curve. It must be understood that the specimens were dried in air with no attempt to control relative humidity which varies from day to day.[10]

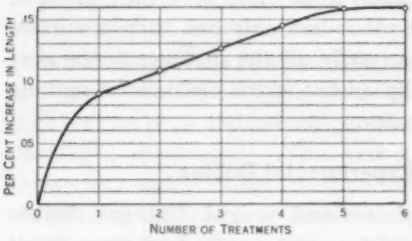


FIG. 1.—Effect of repeated autoclave treatments on Body No. 1.

(2) Effect of Pressure and Heat without Steam

To show that either pressure or heat alone did not cause crazing, several samples were subjected to (*a*) 150 pounds pressure by attaching a tank of compressed CO_2 gas to the dried autoclave; (*b*) 185°C for 17 hours. Neither treatment caused any crazing or permanent increase in length. A combination of pressure and heat also failed to cause crazing of the specimens.

TABLE II

COMPARISON OF RESULTS (BODY NO. 1) WHEN COOLED UNDER STEAM PRESSURE AND WHEN COOLED UNDER AIR PRESSURE

Bar No.	Per cent weight increase	Average	Treatment
12	0.44		Cooled under steam
26	.43	0.44	"
50	.41		"
51	.46		"
16 (from Table I)	.36		Cooled under air
17 "	.29		"
18 "	.25	.30	"
19 "	.31		"
85 "	.31		"
91 "	.30		"
	Per cent length increase		
74	0.098		Cooled under steam
76	.087	0.088	"
95	.100		"
98	.066		"
88 (from Table I)	.094		Cooled under air
89 "	.084	.089	"
93 "	.066		"
94 "	.114		"

[10] E. W. Washburn and F. F. Footitt, "Porosity. III. Water as an Absorption Liquid," *Jour. Amer. Ceram. Soc.*, **4**, 967 (1921).

(3) Effect of Fast and Slow Cooling

All previous tests had been made by opening a valve and reducing the steam pressure of the autoclave to zero immediately after the specified time had elapsed. The data in Table II show the effect of leaving the valve closed after removing the source of the heat and allowing the pressure to decrease normally as the autoclave cooled. Comparative data are inserted from Table I. It is shown that in both cases the increase in length is the same, but that the weight change is much greater when the autoclave is cooled under steam pressure than when cooled under air pressure. It is possible that the residual heat in the specimens and the autoclave is sufficient to drive off some of the moisture when the specimens are cooled under atmospheric pressure only, although this removal of moisture is not accompanied by a proportionate decrease of volume.

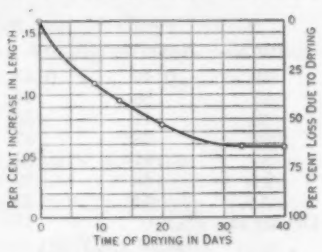


FIG. 2.—Effect of drying at 110°C after repeated autoclave treatments on Body No. 1.

(4) Effect of Drying at 110°C

The bars which had been treated six successive times in the autoclave were dried at 110°C for 40 days, during which time their changes in length were measured after 9, 13, 20, 33, and 40 days. The results are given in Table III and the averages have been plotted in Fig. 2. It is to be noted

TABLE III

EFFECT OF DRYING AT 110°C ON LENGTH CHANGE AFTER REPEATED AUTOCLAVE TREATMENTS (BODY NO. 1)

		Per cent increase in length after drying at 110°C for x days				
Bar No.	No drying*	9	13	20	33	40
88	0.178	0.130	0.127	0.101	0.073	0.069
89	.154	.104	.081	.055	.048	.047
93	.148	.093	.076	.065	.034	.038
94	.153	.109	.096	.083	.073	.072
Av.	.158	.109	.095	.076	.057	.057
Drying loss (%)	0	31	40	52	64	64

* Other than the 24 hours before measurement after sixth treatment.

that the bars never returned to their original length but at the end of 40 days still showed an average expansion of 0.057%.

Data given in Table IV show the effect on change in weight of prolonged drying at 110°C for bars which had previously been subjected to six successive autoclave treatments of 150 pounds per square inch for one hour. Specimens were cooled in a desiccator upon being removed from the drier. The erratic behavior of this data is probably due to variations in the humidity of the air since it is known that porous clay bars take up varying

amounts of moisture when exposed to varying humidities.[10] It is probable that smaller pieces would lose their weight increase much more quickly than these samples which were one inch square by three inches long.

TABLE IV

EFFECT OF DRYING AT 110°C ON WEIGHT CHANGE AFTER REPEATED AUTOCLAVE TREATMENTS (BODY NO. 1)

		Per cent increase in weight after drying at 110°C for x days				
Bar No.	No drying*	3	4½	6	13	20
16	0.46	0.43	**	0.44	0.37	0.34
17	.56	.45	0.34	.33	.11	.13
18	.41	.35	.27	.26	.03	.04
19	.38	.37	**	.39	.31	.32
85	.41	.38	.39	.38	.18	.16
91	.43	.39	.40	.40	.15	.15
Av.	.44	.39	.35	.37	.19	.19
Drying loss (%)	0	11	20	16	57	57

* Other than the 24 hours before weighing after the sixth treatment.
** Not weighed at this period.

(5) Effect of Drying at Room Temperature

The data in Table V show the effect of drying two bars at room temperature (approximately 25°C) after they had been subjected to a steam pressure of 150 pounds for one hour and cooled under steam pressure.

TABLE V

EFFECT OF DRYING (UNDER CONSTANT HUMIDITY) AT ROOM TEMPERATURE AFTER A SINGLE AUTOCLAVE TREATMENT (BODY NO. 1)

		Per cent increase in weight after drying at room temperature for x hours					
Bar No.	No drying*	24	48	72	96	120	144
20	1.47	0.644	0.642	0.637	0.625	0.622	0.620
62	1.25	.651	.649	.646	.634	.631	.630

* Weighed immediately upon coming from the cooled autoclave. Bars were protected to prevent condensed moisture from dripping on them.

Drying was accomplished by means of a vacuum pump by taking air from the room through two calcium-chloride containers and then through a bell jar in which the bars wereplaced. These data indicate that drying porous bars under constant humidity conditions will give regular weight-change curves and show that the erratic behavior of the data reported in Table IV is probably due to changes in relative humidity.

(6) Effect of Treatment in Some Nonaqueous Liquids

If the change in length was not due to rehydration then it was reasonable to assume that other liquids besides water might cause a similar change in length, the change in each case being characteristic of the liquid *if* equilibrium conditions were reached. Accordingly, a reflux condenser was set up and the effects of prolonged immersion in several hot or boiling liquids determined. In all cases the bars were nearly

submerged in the hot liquid and were measured immediately upon cooling in the liquid (except in the case of paraffin and petrolatum where the bars were cooled after being removed from the hot liquid) to normal room temperature. Table VI gives the results obtained. Bars made of Body No. 1 fired to cone 3+ were selected since the liquid would penetrate more rapidly than if the bars were fired to a higher temperature.

TABLE VI

EFFECT OF TREATMENT IN SOME NONAQUEOUS LIQUIDS (BODY NO. 1)

Bar No.	Firing temperature	Liquid used	Method of treatment	% increase in length
42	Cone 3+	Water	Boiled 22 hr.	0.096
66	"	"	" "	.098
77	Cone 5+	CCl_4	Boiled 140 hr.	.046
84	"	"	" "	.035
59	Cone 3+	Paraffin	Heated above 100°C for 100 hr.	.042
31	"	"	" " " " " "	.026
37	"	Xylene	Heated above 100°C for 12.5 hr.	.012
52	"	"	" " " " " "	.026
44	"	Kerosene	Heated above 100°C for 96 hr.	.014
45	"	"	" " " " " "	.021
41	"	Petrolatum	Heated above 100°C for 48 hr.	.017
53	"	"	" " " " " "	.019

All the liquids which boil below 100°C were first dried carefully by slaking with anhydrous calcium chloride, allowing to stand for several hours, then decanting the liquid and repeating the process until new calcium chloride showed no slaking. Although these treatments may not remove all the water present, it is thought that if calcium chloride will not remove it, the clay bar will also be unable to remove it. All the liquids which boil above 100°C were immiscible with water but were heated in the open at nearly their boiling point for from two to four hours before introducing the specimens. It was thought that there could not have been sufficient water left to account for the changes in length. If the changes in length were due to experimental errors of measuring, then it is reasonable to assume that part of the changes would be decreases and part increases. In no case, however, were any decreases in length found.

It is interesting to note that all of the liquids caused an increase in length. No attempt was made to secure equilibrium since such a procedure would necessitate taking measurements until no further change occurred. This was impossible because of insufficient time available. The data point to the probability that the increase in length may be due to causes other than the rehydration of any constituent in the body.

(7) Effect of Composition In an attempt to show the effects of feldspar, clay, and flint on the change in length, the following bodies were prepared and each body fired to cones 5 to 6, 8 to 9, and 11 to 12.

	Body No. 1 (%)	Body No. 2 (%)	Body No. 3 (%)
Total clay	52	56	48
MWM English china	29	31.2	26.8
Florida kaolin	8	8.6	7.4
Tennessee ball No. 7	15	16.2	13.8
Flint	34	26	34
Buckingham feldspar	14	18	18

Although the clay content varied, the ball clay-china clay ratio was constant in all three bodies. These bodies were glazed for reference marks

TABLE VII

EFFECT OF FIRING TEMPERATURE AND ABSORPTION ON THE AUTOCLAVE EXPANSIONS OF SOME BODIES AND CLAYS

Body or clay	Per cent increase in length at cones 5–6	8–9	11–12
Body No. 1*	0.090%	0.077%	0.061%
Clay 52%			
Flint 34%			
Feldspar 14%			
Average absorption	12.5	11.8	8.7
Body No. 2*	0.109	0.097	0.081
Clay 56%			
Flint 26%			
Feldspar 18%			
Average absorption	7.8	7.8	4.3
Body No. 3*	0.107	0.089	0.070
Clay 48%			
Flint 34%			
Feldspar 18%			
Av. absorption	9.6	7.9	4.8
MWM English china clay*	0.066	0.049	0.031
Av. absorption	22.2	21.9	18.9
VC 1 English china clay*	0.073	0.062	0.045
Av. absorption	21.2	20.6	18.0
Florida kaolin	0.045	0.021	0.011
Av. absorption	14.8	13.3	10.9
Georgia kaolin	0.032	0.021	0.005
Av. absorption	20.7	17.8	14.8
Black English ball clay No. 90	0.000**		
Av. absorption	0.4		
Light English ball clay No. 82*	0.000**	0.000**	0.000**
Av. absorption	0.0		
Tennessee ball clay No. 7	0.014	0.000**	
Av. absorption	1.3		
Kentucky ball clay No. 4	0.000**		
Av. absorption	0.1		

* Samples were dried for 24 hours at 110°C after coming from the autoclave and before measurement. Those not starred once were measured immediately upon coming from the cooled autoclave.

** The readings taken before and after the autoclave treatment showed no variations greater than the error in reading the vernier scales of the micrometer microscopes.

and subjected to a three-hour autoclave treatment at 150 pounds steam pressure. They were then dried for 24 hours at 110°C, measured, and the changes in length noted. The results given in Table VII are the averages for five bars of each body at each cone temperature. The absorptions as

determined by the Standard Method[11] are also given in the table. Figure 3 shows that there is a general relationship between firing temperature and increase in length and that the volume increase is very great when compared to that of bodies made of pure clays. It is noted that on replacing clay by feldspar there is an increase in length change, although the change is little more than the experimental error involved in the measurements. Also, on increasing clay at the expense of flint, with feldspar constant, a greater expansion is secured. Very much more data would be necessary before any definite conclusions could be reached, but it can be said that the percentage variations in feldspar and flint which are possible within the semiporcelain body field are too small to cause any great change in reaction of the body to the autoclave treatment. This statement probably does not apply if small amounts of fluxes other than feldspar are added.[6]

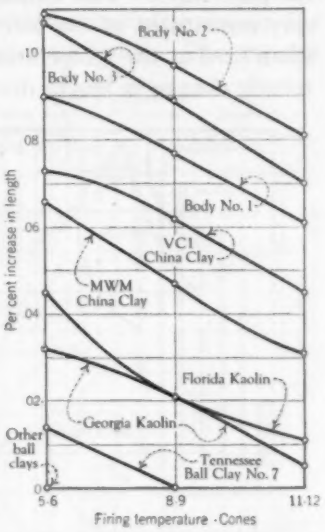


FIG. 3.—Effect of firing temperature on increase in length of bodies and clays.

(8) Expansions of Some Clays

Since clays are the main constituents in whiteware bodies and also the constituents that vary the most in purity, mineralogical content, fineness, etc., it seemed desirable to study representative clays as to their reaction to the autoclave treatment. Accordingly, bars of the following clays were prepared and fired to cones 5 to 6, 8 to 9, and 11 to 12.

China clays	Ball clays
MWM English china	Black English ball clay No. 90
VC 1 English china	Light English ball clay No. 82
Edgar County, Fla.	Tenn. ball clay No. 7
Georgia kaolin from McIntyre, Ga.	Ky. Old Mine No. 4 ball clay

These bars were autoclave-treated for three hours under a steam pressure of 150 pounds and their changes in length noted. The results given in Table VII are the averages for five bars of each clay at each cone temperature. Those bars which were not dried for 24 hours at 110°C were measured immediately upon removal from the cooled autoclave. Absorptions are also indicated.

The two English china clays showed a much greater length change than did any of the other clays (Fig. 3). It is interesting to note that the bodies

[11] Standard Test Methods, *Jour. Amer. Ceram. Soc.*, **11** [6], 455–57 (1928).

composed of feldspar, clay, and flint showed a greater length change than the pure clays. This indicates that the changes are not due solely to the clay constituent of the body. The results show definitely that ball clays when fired at the temperatures used in this study do not show any characteristic change in length due to the autoclave treatment.

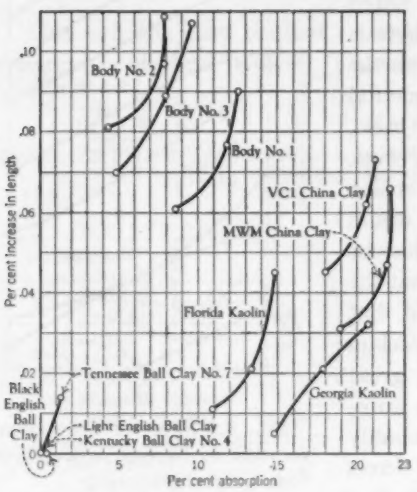


FIG. 4.—Effect of absorption on increase in length of bodies and clays.

(9) Effect of Absorption Figure 4 shows the effect of absorption on the increase in length due to the autoclave treatment. It can be seen that the composition of a body is a more important consideration than its absorption as an indication of its reaction to the autoclave treatment, although, with a body of the same composition, a greater absorption indicates a greater change in length.[6]

IV. Results on Commercial Bodies

Several samples of commercial bodies (made into bars at the factory and fired in commercial kilns) supplied by various manufacturers were subjected to a 3-hour autoclave treatment under 150 pounds steam pressure and their length changes determined. The absorptions of these bodies were also deter-

TABLE VIII

AUTOCLAVE EXPANSIONS OF SOME COMMERCIAL BODIES AS COMPARED WITH ACTUAL WEATHERING AND STORING

Body	Per cent increase in length due to Autoclave treatment	Six months* Outdoors	Six months* Damp jar	Twelve months** Outdoors	Twelve months** Damp jar	Absorption of bars used in the autoclave treatment (%)
Buff wall tile body	0.057	0.016†	0.009	0.032‡	0.025	6.6
Cream wall tile body	.016	.015	.010	.028	.030	2.1
White wall tile body	.069	.053	.053	.053	.070	15.0
Terra cotta						
Hard	.045	.006	.006	.020	.028	11.2
Soft	.056	.030	.025	.034	.043	12.5
White semivitreous dinnerware	.071	.063	.053	.072	.076	9.6
Ivory semivitreous dinnerware	.065	.063	.048	.086	.078	7.8

* From June to December.
** From June to June.
† Average of four bars only.
‡ Result on one bar only; remaining bars spalled during last six months.

mined. Samples of the same bodies were also subjected to a twelve months' outdoor weathering test and to twelve months of damp storage in a closed jar over water. The length changes were noted after six months and again after twelve months of storing and weathering. The results (averages for five bars) are given in Table VIII and plotted in Fig. 5. The data are sufficient to show that unless ceramic bodies approach vitrification, they will probably show some changes due to the autoclave treatment and that, in general, these changes will show the same comparative trend as weathering either outdoors or in a damp jar.

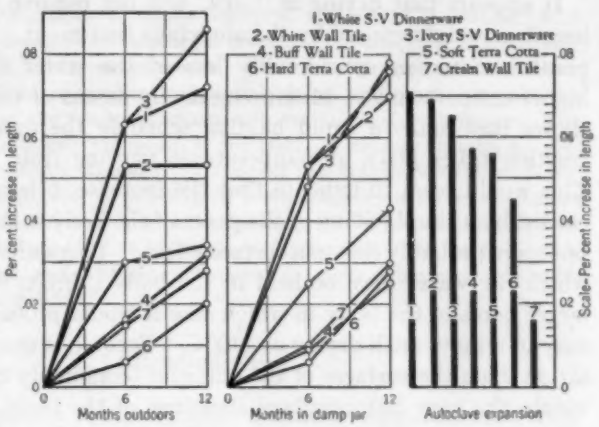


FIG. 5.—Relation between increase in length due to autoclave treatment and that due to actual weathering and storing.

A study by means of the interferometer (according to the method explained by Schurecht[3]) showed that in the case of a wall-tile body which had been stored for 25 years a 3-hour autoclave treatment under 150 pounds steam pressure caused a greater change in length than did the 25 years' storage. The aged body on first heating in the interferometer apparatus showed a contraction of 0.07% over the second heating. After the second heating the small interferometer cones were given the autoclave treatment and heated for a third time. They showed a contraction of 0.10% over the second heating. The maximum temperature attained in each run was 650°C. On another aged sample it was found that a glaze might withstand a body expansion of 0.115% without crazing.

V. General Conclusions

The autoclave treatment causes an increase in the volume of porous ceramic bodies accompanied by a corresponding increase in weight, the two being roughly proportional. The rate of increase in volume or weight is rapid at first and decreases with increase in time of treatment.

Indications are that the expansion due to the autoclave treatment is not due to high temperature or pressure except in the presence of steam or water vapor. It may be caused by steam or water vapor at about boiling temperature. Since bodies composed of feldspar, clay, and flint show a higher

volume increase than do the pure clay constituents, it appears that the volume increase is not due to the rehydration of the clay molecule. Schurecht[6] found that bodies composed of clay and feldspar gave considerably less expansion than did bodies composed of clay, feldspar, and 20% flint.

It appears that drying at 110°C will not remove the entire increase in length or weight caused by the autoclave treatment. Drying at room temperature removes considerably less of the water than does drying at higher temperatures. Measurements by means of the interferometer have shown that under a rapid heating schedule the greater part of the contraction takes place at temperatures varying from 175°C up to 350°C. This would seem to indicate that the increase in length and weight is not caused by a simple filling of the pores of the body with vapor or liquid water but more probably due to a surface effect. There are three possible ways in which the water may be held in the body. First, it may be held in the larger pores of the body in which case it would probably be comparatively easy to remove with drying at 110°C. Second, it may be held as a condensation upon the surfaces of the particles (commonly called adsorption) and within the very fine capillary structure of the body. Water held in this manner would probably resist complete removal at 110°C and would show a definite equilibrium at each drying temperature. Third, it may be held within the particles either in chemical combination (water of hydration), in which case there would be a rather definite temperature range of dehydration or in solid solution. A mixture of hydrates, however, would show several ranges of dehydration, *i.e.*, one corresponding to every hydrate present. In the case of the autoclave treatment it is quite possible that the bodies take up water by a combination of the three ways mentioned above. The vapor pressure of water is lowered very materially when it is held on a surface or in very fine capillaries, so that the water does not have to be in chemical combination to resist removal at 110°C. The data presented in this paper tend to point toward adsorption or a combination of adsorption and the partial filling of the pores of the body with water or water vapor.

The results of this work confirm Schurecht's results in that (1) the composition of a body is a more important factor than its absorption in determining its reaction to the autoclave treatment, but for bodies of the same composition increased absorption (decreased firing temperature) is accompanied by increased change in length, and (2) all porous ceramic bodies are subject to the change in volume as caused by the autoclave treatment.

Unless ceramic bodies approach vitrification, they will show increase in volume due to the autoclave treatment and in general, this change will show the same trend as weathering.

Acknowledgment The writer wishes to thank A. S. Watts and T. A. Klinefelter, under whose joint direction this investigation was carried on, and F. P. Hall, for their assistance throughout the course of the investigation.

THE ELECTRICAL DEWATERING OF CLAY SUSPENSIONS[1]

By Carl E. Curtis[2]

ABSTRACT

The history of the developments by Count Schwerin, application at Carlsbad with detailed description of the plant, and review of the investigations of others on dewatering of clays by electrophoresis, are given at length. The investigations by the author, including a description of the apparatus, materials, voltage, and electrolytes are described with a statement of the results obtained with variations of each factor. The possible efficiency as a clay dewatering means is discussed. Plasticity theories are discussed in the light of the evidence obtained. The power cost is from 65 to 80 cents per ton of clay. On the average, clay dewatering by electrophoresis is no more efficient than the filter-press, but it has shown greater efficiency on very fine-grained clays. Bibliographies are appended on (1) colloids in clays, (2) theories applying to electro-endosmosis, (3) electromosis, and (4) Schwerin's patents. A short biographical sketch of Count Schwerin is also appended.

I. Introduction[3]

(1) History of Process The action of the electric current on suspensions of solid particles in liquids was discovered by Reuss of Moscow in 1808. He inserted two glass tubes vertically in a lump of moist clay, filled the tubes with water, and by means of electrodes, sent an electric current through the apparatus. The water in one of the tubes rose while that in the other fell and at the same time became cloudy. He gave the phenomenon the rather formidable name "motus stoechiagogus." Fortunately, this has been replaced by more euphonious terms. Reuss thus discovered that under the influence of a direct electromotive force the water migrated through the somewhat porous clay diaphragm toward one electrode while loose particles of solid clay migrated to the opposite electrode.

This phenomenon has attracted the attention of many investigators, especially in the field of physical chemistry, who have given considerable time to the study of the electrical behavior of various suspensions and liquids.*

---

[1] Presented at the Annual Meeting, American Ceramic Society, Cleveland, Ohio, February, 1931 (White Wares Division). Received November 10, 1930.

This paper presents the results of work done under a coöperative agreement between the United States Bureau of Mines and the College of Mines, University of Washington. Published by permission of the Director, U. S. Bureau of Mines.

[2] Research Fellow in Nonmetallics, Northwest Experiment Station, U. S. Bureau of Mines, in coöperation with the University of Washington.

[3] The process of removing solid materials from liquid suspension has been studied at the Northwest Experiment Station, U. S. Bureau of Mines, in coöperation with the University of Washington, as a part of a general program in investigating the dewatering of Pacific Northwest plastic kaolins. The present paper is a progress report of the work started by Vance S. Cartwright (see footnote 2) in 1928 and continued by Howard S. Davis (see footnote 2) in 1929, and the present author in 1930.

* See Bibliography, p. 257, references 1 to 39.

It has been found that many liquids, under the influence of a unidirectional electromotive force, may be forced through stationary diaphragms. The term "electrosmosis" has been proposed by O. C. Ralston* to replace a number of other names which have been given to this phenomenon. Likewise, it has been found that most solid materials, when suspended as fine particles in a liquid, acquire an electric charge. Under the influence of a unidirectional electromotive force, these particles can be made to travel toward one of the electrodes. Ralston has proposed that this traveling of solid particles through a liquid due to the application of electrical forces shall be called "electrophoresis."

(2) Developments by Count Schwerin

The present development of electrophoresis, as applied to clays, can be ascribed to Count Botho von Schwerin.† The process which he perfected and machines of the type that he developed are being used at the present time for the dewatering of clays in the plants of the Carlsbad Electro-Osmose Company at Chodau, Czechoslovakia and in two other plants located in Saxony and East Prussia. Schwerin first attempted to apply the principle of electrophoresis to the dewatering of peat, a process which is rather difficult with ordinary methods due to the large amount of colloidal matter present. Accordingly, his first patents were for the removal of water from materials with the consistency of stiff mud. The progress of the development of his ideas may be gained from the description of his patents which follows.

(3) Schwerin's Patents in the United States ‡

The first patent (U. S. 670,350) obtained in this country by Schwerin was issued in 1901. It consisted of two vertical cylinders, one inside the other. The space between these formed the electrophoresis chamber. The inner cylinder was the anode and the outer drum was the cathode. As the latter pole attracted the water, it was lined with some porous material, such as wire screen, and a space between this and the outer metal wall provided a channel for the escape of the water. The wet peat was introduced into the bottom of the outer drum and was moved upward between the metal cylinders by means of a spiral screw which revolved with the inner cylinder. Schwerin, in speaking of this machine in a later patent, says that it did not give a sufficiently large yield to justify its use.

The second patent (U. S. 720,186) issued to Schwerin (in 1903) applied the electrosmosis treatment on a larger scale. It consisted essentially of a series of rectangular trays, forming the cathodes, the bottoms of which were made of wire screen. The anodes were metal plates which could be lowered into the trays. The operation was carried out as follows: The trays were first filled with peat and placed in racks. All of the anodes in a given tier of racks were then lowered into the cathode boxes by a single operation. A direct current was then turned on and, under the combined influence of gravity and the electrical difference of potential, the water moved to the bottom of the trays and escaped through the porous bottom. When the dewatering had proceeded as far as practicable, the trays were removed and freshly loaded ones were put in their places. The chief defects of this

---

* Reference 35, p. 258.

† See p. 263 for Work of Count Schwerin.

‡ For list of Schwerin's patents, see p. 261.

machine, according to Schwerin, were that it was not continuous and that it involved too much labor and attention.

The third invention (U. S. 894,070 (1908)) was designed to overcome these defects. Its construction was briefly as follows: Two continuous belts of porous cloth carrying the peat between them moved between two electrodes. The cathode was placed below the lower belt and the anode above the upper belt. The water in the peat was thus subjected to the combined pulls of gravitation and the electrical difference in potential as before. Accordingly, it moved downward and escaped through the porous lower belt. The dewatered material was carried forward by the moving belts and discharged continuously. This device could not be used for the dewatering of suspensions of low viscosity, such as are encountered in clay washing.

In 1910, Count Schwerin patented in this country a device described as "A Method of and Apparatus for Generating Electricity" (U. S. 972,029). This device was an application of Perrin's discovery that, when a suspension is forced through a diaphragm, an electric difference of potential is produced between the sides of the diaphragm. This is the opposite of the electrosmosis process.

The following year, a patent (U. S. 993,888) was granted to Schwerin for separating substances in suspension by adding a "strongly non-neutral colloidal body" which will be absorbed by the substance in suspension, adding an electrolyte capable of neutralizing the ion normally liberated at the electrode toward which the substance tends to migrate, and subjecting the material to electrosmosis. Another patent (U. S. 1,029,579) followed in 1912. This applied to the method now used in Carlsbad, wherein an electrolyte is added to the suspension of fine sand and clay. Because of the resulting dispersion of the suspension, the sand settles out and the clay remains in suspension. A separation is thus effected. A third patent (U. S. 1,121,409) along the same line was obtained in 1914. This consisted in grinding the substance as finely as possible in the presence of an electrolyte before subjecting it to electrophoresis.

The three dewatering machines described thus far were suitable only for viscous materials, such as peat. In 1915, Schwerin secured patents on the revolving-drum electrophoresis machine and the electro-osmotic filter press. The latter (U. S. 1,156,715) is the ordinary filter press with the added electro-osmotic feature. It is similar in construction to the ordinary plate filter press except that two metal screens are placed between the plates in each filter chamber and serve as the electrodes. By means of these a direct current is passed through the suspension and at the same time a small amount of pressure is applied. The water passes through the screen cathode and escapes. In this way, Schwerin claims, dewatering can be accomplished at a fraction of the pressure required for the ordinary filter press. Machines of this type are being used to alternate with the electrophoresis machines at the Carlsbad plant.

Schwerin's drum-anode electrophoresis machine was also patented in 1915 (U. S. 1,133,967). This machine served as the model for the one constructed in this laboratory by H. S. Davis,* which was used in the experiments recorded in this paper. The apparatus is described as an "Apparatus for Electro-osmotic Processes."

* See reference 63, p. 259.

The principal parts of the machine as described in the patent are a small tank or housing which holds the suspension, a semicircular permeable cathode suspended in this, and, above the cathode, a revolving metal drum which dips into the liquid and serves as the anode. The tank is divided longitudinally by a partition which extends upward to the cathode. A paddle wheel is placed in each of the two chambers to prevent the suspension from settling and to direct it upward through the cathode toward the anode.

The suspended particles collect on the revolving anode drum and are removed continuously by a scraper.

In 1916, a patent (U. S. 1,174,946) was obtained by Hans Illig which related to methods of forcing the suspension through a cathode and removing the depleted suspension and settlings from the bottom of an electrosmosis machine of the drum type previously patented by Schwerin.

Again in 1917, Schwerin obtained the third patent (U. S. 1,229,203) relating to the final form of his electrophoresis machine. This patent outlines the process of blunging, settling of the coarser materials, and finally, subjecting the very finest material to the action of the electric current. This is essentially the method of procedure in use at Carlsbad. In the patent it is maintained that part of the materials in suspension may be separated into fractions in a series of settling troughs. A further fraction is removed in the electrophoresis machine.

Schwerin's patent (U. S. 1,233,713 (1917)) covered the use of basic electrolytes in the elutriation of clay, etc., to cause dispersion of the suspension, which allows the coarser material to settle and form a dense deposit, freer from water than is possible without deflocculation. Patent U. S. 1,235,063 related to the separation of colloidal materials by means of a diaphragm and electric current in a specially constructed cell. Patent U. S. 1,266,329 (1918) covers in a general way the operation of the electro-osmotic filter press.

(4) The Carlsbad Elektro-Osmose Plant

The following information relating to the company and description of the plant were kindly presented by Willi Meyer, manager: On the basis of the laboratory experiments and patents of Count Schwerin, a plant was erected in 1910 at Steinefrenz, Westerwald, to try out the electro-osmotic purification of clay on a larger scale. Because of the good results obtained there, the United Gross Almerode Clay Works installed the clay conditioning process in their plant at Gross Almerode, near Kassel. This plant, after considerable expansion, is still in operation, producing plastic, refractory clay used mainly in glass pots.

Shortly before the war (1913), an experimental plant was erected at Sutton, near Mansfield, England. In this plant almost all of the English clays and kaolins were given an electro-osmotic test for purification. The outbreak of the war ended this work and the seizure of the English patents of the company stopped the development in that country.

The experiences obtained in the various experiments and in Gross Almerode encouraged the Osmose Company to enter the field of kaolin preparation and it was at this point that the Carlsbad Elektro-Osmose Aktien Gesellschaft was founded in April, 1914, with a capitalization of one million gold crowns (Fig. 1).

At its formation the corporation acquired 530,000 square meters (132.5

FIG. 1.—New plant of the Carlsbad Electro-Osmose Corporation near Chodau, Czechoslovakia.

acres) of kaolin property as well as two lakes with 100,000 square meters (25 acres) of surface, thus obtaining water adapted to clay washing. The present kaolin bed owned by the Carlsbad E.O.A.G. has an average thickness of 15 meters (49.2 feet) and corresponds to the famous Roherden in quality. Besides its own kaolin deposit, the Carlsbad company owns the mining rights over an area of 600,000 square meters (150 acres).

The plant (Fig. 2) when erected was equipped with four osmosis machines. In 1916 two more machines were installed; in 1920 an electro-osmotic filter press was added and a second one in 1926; so that the present capacity of the plant is 70 tonnes (metric, or 77 tons of 2000 pounds) of "edelkaolin" ready for shipment per 24 hours. It likewise produces about 30 tonnes (33 tons of 2000 pounds) of No. 2 kaolin which is used in the paper

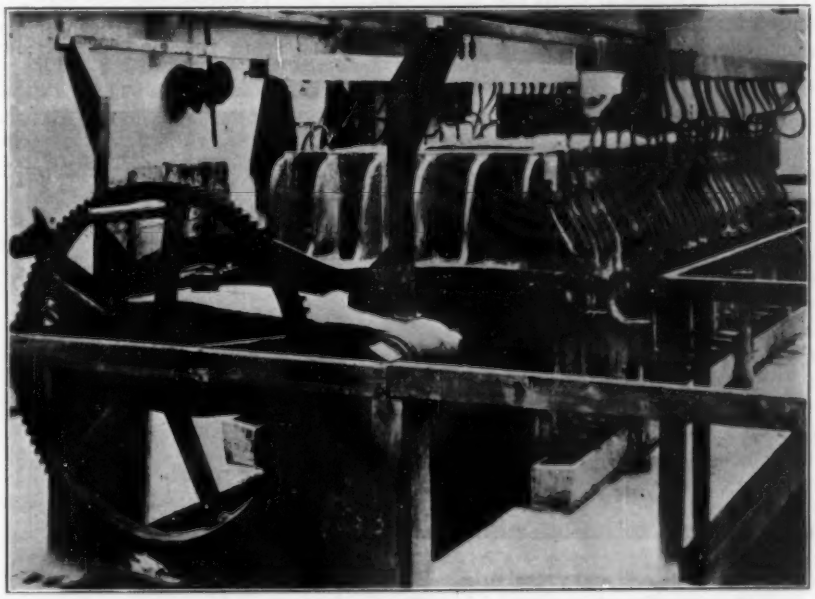


FIG. 2.—Electro-osmotic filter press used in the Chodau plant to alternate with the electrophoresis machines.

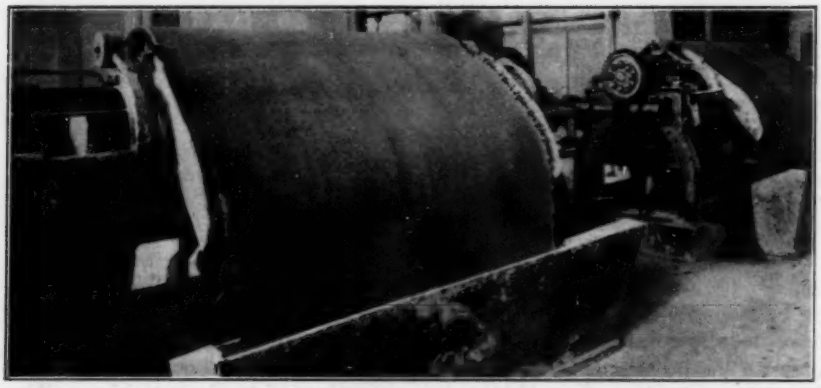


FIG. 3.—Electrophoresis machines in the Carlsbad plant. Four of the six machines are shown. The belt of clay is 4.7 feet wide, approximately 1/8 inch thick, and contains 35% water.

industry. This plant is one of the largest kaolin-washing plants of Europe and produces a recognized brand of clay (Edel-Kaolin Brand) for fine porcelain (Figs. 3 and 4).

The electro-osmotic preparation of the kaolin by the Carlsbad E.O.A.G. is shown on the accompanying flow-sheet by Herr Meyer (Fig. 5). The raw kaolin is brought from the mines and fed into crushers and the finely-divided kaolin is extracted by means of rotary blungers. Into these, fresh water, electrolyte, and the depleted suspension from the electrophoresis

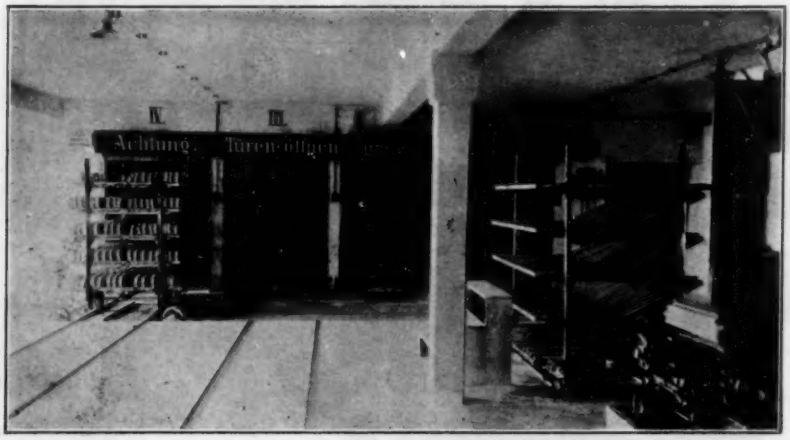


FIG. 4.—Pug mill and tunnel drier. The column of edelkaolin is seen emerging from the pug mill at the extreme right. The die gives a special form to the column, which may be seen in the material on the car which is entering the drier.

machines are introduced, and the raw clay is dispersed. The separation of the coarse sand is made by the blungers while the suspended kaolin flows into the fine-sand troughs (No. 2, Fig. 5) where it is removed by hand.

From the fine-sand troughs the suspensions run into channels in which No. 2 kaolin separates;* this is then dug out of the channels (3) by hand and dried in a rotary drier (14) heated with producer gas. The suspension, which now has been separated from its impurities, flows into agitators (4) and is then conducted through the distributing channels (5) to the osmosis machines (7) and osmotic filter presses (8) for dewatering. The edelkaolin, which has been removed by the osmosis machines, goes to an auger machine (9) which gives it a special (hollow) shape for drying. The molded pieces are stacked on trucks and placed in drying tunnels (10). The filter-press cakes are loaded directly on cars and dried in a similar fashion by means of hot air. The yield in edelkaolin amounts to 25% and its rational analysis shows a clay content of 98%. The remainder is quartz. The fired color at Seger cone 14 is white; the material is highly plastic and lends itself excellently to the production of the best porcelain.

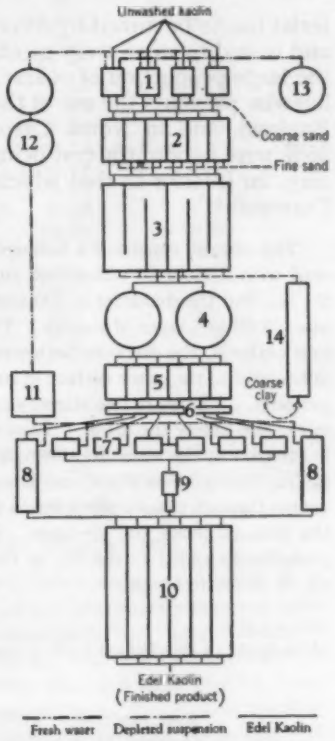


FIG. 5.—Flow sheet of a kaolin-washing plant using electrophoresis. 1. Excelsior blunger. 2. Fine-sand settling system. 3. Settling system. 4. Planetary agitator. 5. Distributor. 6. Distributing channels. 7. Electrophoresis machine. 8. Electro-osmotic filter presses. 9. Auger machine. 10. Tunnel drier. 11. Sump for depleted suspension. 12. Agitator for depleted suspension. 13. Fresh water storage. 14. Rotary drier.

Shortly after the war the electro-osmotic clay and kaolin process was introduced into Germany on a large scale in the largest of the German kaolin washing plants, the "Seok" Saxony Electro-Osmose Kaolin-Washing Company, Ltd., Kennlitz, Saxony. The Carlsbad Electro-Osmose Corporation in 1928 and the "Seok" Saxony Company in 1929 came into possession of the Zettlitz Kaolin Corporation. The Zettlitz kaolin was made the world standard brand of kaolin at the International Congress of Applied Ceramics in Copenhagen. The above-mentioned company, therefore, produces the world's only supply of electro-osmotically prepared clay and kaolin. The Zettlitz Kaolin Corporation has also acquired from the Electro-Osmose Corporation in Berlin a general license for the use of both its patents and its secret methods.

* See Fig. 5 for numbered references in parentheses.

(5) Additional Notes on the Carlsbad Plant by S. R. Hind* and Others

The raw material is obtained from two underground mines and a quarry in the neighborhood and only the cleanest material is sent to the plant. The raw material has to be mined by direct manual labor as it is too plastic for blasting and is said to wear away mechanical excavators very quickly on account of the large proportion of coarse, sharp sand it contains. The plastic nature likewise prevents the use of the washing-out method employed in Cornwall, England, and in North Carolina. The material is said to contain only 25% pure kaolin, the rest being quartz, fine sand, and mica. It is a "china clay, far inferior to that which the British potters have at their disposal in Cornwall.†"

The drums‡ consist of a homogeneous alloy of lead with 15% antimony and are covered with a layer of vulcanized rubber.* The length of the drum is 1432 mm. (4 ft. 8.4 in.) and the diameter is 600 mm. (1 ft. 11.6 in.), the drum being complete with a 10 mm. (0.39 in.) layer of rubber. The lower half of the drum anode is surrounded by a grid cathode, the distance between them being 23 mm. (0.9 in.) from the inner surface of the grid to the outer surface of rubber. The drum rotates at a speed of 18 revolutions per hour. There are two stirrer shafts parallel and in the same horizontal plane working in the slip below the drum. They revolve at 170 r.p.m. The suspension is fed into the lower part of the machine through a control-valve and overflows at the surface, finally falling through two pipes, one at each end of the machine, into a lower tray, whence it drains through copper pipes into a sump on the floor below. From here it is pumped to the storage above the blungers. Sodium silicate (diluted with water) as required, is periodically added to the slip in the sump. The machines each treat approximately 6 cu. m. of slip per hour.

TABLE I

MOISTURE IN MATERIALS AT VARIOUS STAGES OF THE PROCESS AT CARLSBAD (HIND)

	As first handled (%)	From driers (%)
Raw material	15	
Sand	5–10	
Schlicher	35–40	3–5
Edelkaolin	35	10–12

(6) Investigation of Electro-Osmosis by Hind

Hind* also made some investigations of the effect of the electro-osmotic process on the Carlsbad clay. He states in part:

A sample of kaolin from the osmosis machine and as delivered from the driers, was submitted to analysis and a test for refractoriness. This was compared with a sample of clay prepared from the raw material used at Chodau by sedimentation of the impurities and recovery of the whole of the remaining suspended material.

The raw material was worked up with water and deflocculated with sodium silicate, washed through lawns up to 200-mesh (to take out the coarse grit) and allowed to settle at a depth of 24.5 cm. until the slop weight decreased from 24.1 oz. per pint to 22.8 oz. per pint. The slip was then gently evaporated until dry. Table II shows the results of the tests on the two products.

---

* Reference 68, p. 259.

† Reference 86, p. 260.

‡ See Fig. 3.

TABLE II

HIND'S TESTS ON CARLSBAD KAOLIN

Original sample	Osmosed product	Settled only
Refractoriness: cone	36	36
Squatting temperature	1790°C	1790°C
Chemical analysis	(%)	(%)
SiO_2	45.13	45.66
TiO_2	0.51	less than 0.01
Al_2O_3	37.89	37.12
Fe_2O_3	0.94	0.87
MgO	0.29	less than 0.01
CaO	0.48	0.46
K_2O	0.78	0.88
Na_2O	0.58	0.74
Ignition loss	13.52	13.86
Rational analysis (calculated)		
Clay	90.2	88.5
Feldspathic (or micaceous) matter	8.1	9.7
Quartz	Nil	Nil
Iron oxide (Fe_2O_3)	0.9	0.9
Lime (CaO)	0.5	0.5

Hind concludes:

One is, therefore, led to believe that, for all practical purposes, the whole of the purification of the material takes place in the preliminary settling, the osmosis machine being simply a convenient means for removing the clay from the suspension.

In a personal letter dated March 6, 1930, Mr. Hind states:

The experimental work on the residue of the paper* (which was not published) dealt with attempts to purify a local coal-measures fire clay, of the type which weathered down noticeably to a plastic mass in a month or two and contained a fairly large amount of pyrites. Its refractoriness on sedimentation and "osmosis" was raised from cone 26 to 29. The purification resulting from preliminary settling was such as to give the same result, *viz.*, cone 29. I concluded that, for commercial purposes, the osmosis machine should be looked on as an alternative to coagulation plus filter-pressing. The clay was rather high in soluble salts and, with current at 1 d. (2 cents) per unit, the cost of osmosis treatment was absolutely prohibitive. I may say that we had a machine from the Osmosis Company rated at an output of 1 cwt. of clay per hour. This was presumably based on easy china clay treatment, as with our material, the best we could do was about 1/4 cwt. per hour.

(7) Investigations by Ormandy† In 1912 W. R. Ormandy described a small "osmose" plant, consisting of a "quartz separator," two settling pits, and the osmose machines. He claimed the following advantages for the process: (1) a much drier product than by filter-pressing, (2) purification of the material (he claimed that osmosed fire clay could be used in place of ball clay); (3) increased refractoriness of the product due to increased alumina content; (4) small amount of labor required; (5) smaller building and ground space than in the case of the ordinary plant and therefore (6) smaller investment; (7) possible separation of clays into fractions with different properties. The following two examples are taken from his reports:

* Reference 68, p. 259.

† References 72 to 78, p. 260.

TABLE III

EFFECT OF "OSMOSE" TREATMENT ON THE SHRINKAGE OF A SANITARY-WARE CLAY FROM HANLEY, ENGLAND (ORMANDY)*

	Shrinkage fired at		
	1000°C	1160°C	1380°C
Unpurified	3.3%	5.26%	7.24%
Purified (1040°)	5.26	10.53	13.16

TABLE IV

EFFECT OF "OSMOSE" TREATMENT ON CHEMICAL COMPOSITION OF DEVON CLAY NO. 2 (ORMANDY)†

	Unpurified	Purified
Al_2O_3	21.86	36.61
Fe_2O_3	1.70	1.02
Fusion point—Seger cone	26.5	30.5
Sintering temperature	1430°C	1220°C

* Reference 72, p. 260.
† Reference 74, p. 260.

A summary of results with the English clays given by Ormandy in this report* is shown in Table V.

TABLE V

SUMMARY OF ORMANDY'S RESULTS WITH "OSMOSE" PURIFICATION OF SOME ENGLISH CLAYS*

Kind of clay	No. tested	Alumina content Decreased	Alumina content Increased	Iron content Decreased	Iron content Increased	Fusion point Raised	Fusion point Lowered	Power consumption kw.-hr./ton Range	Power consumption kw.-hr./ton Average
Ball	8	0	8 cases	5 cases	3 cases	8 cases	0	21–51	26.8
Fire clay	27	0	27 cases	18 cases	†8 cases	26 cases	‡0	20.84	36.5
Red clays	3	0	3 cases	0	3 cases				

* Reference 74, p. 260.
† One clay not reported.
‡ One case showed no effect.

(8) Work of Bleininger A. V. Bleininger conducted some experiments with electrophoresis† at the U. S. Bureau of Standards in 1915. Bleininger, in preliminary tests, with the revolving anode type of machine, found that the best electrolyte for general purposes was sodium hydroxide, although sodium oxalate was better in a few cases; and that the amount of reagent necessary never exceeded 0.2% of the weight of the dry clay. He did not try sodium silicate. He used a 220-volt current. The revolving anode of his electrophoresis machine was 5 inches in diameter and $4^3/_4$ inches in length. The negative electrode consisted of two insulated metal strips beneath the anode. A summary of his results is given in Table VI.

Bleininger drew the following conclusions:

In the general run of clays the suspended clay will be deposited on the anode by the electrical current just as it is, and if it has not been subjected to a sedimentation process,

* Reference 74, p. 260.
† Reference 61, p. 259.

TABLE VI

BLEININGER'S RESULTS WITH ELECTROPHORESIS

Material	Source and condition	Separation	Voltage	Amperage	Electrolyte	Effect of electrolyte
Flint	Finely ground	Separates well	125–180	0.75		Poorer results than with none
Feldspar	Brandywine	No separation				No effect
Feldspar	Maine	Some but not as good as flint	160	0.75		No increase in yield
Ferric oxide	Finely divided	None				No effect
Ferric oxide 6% with N. C. kaolin	"	No reduction in iron content				
North Carolina and Georgia kaolin		Heavy, firm deposits	80–160		0.2% NaOH	
Impure fire clay	No. 3 Aultman, Ohio, 40-mesh	Very satisfactory, fired whiter than original clay			0.1% NaOH	

the quality of the product will not be superior to that of ordinary washed clay. The desired results can be obtained by the chemical washing process.....with the use of the filter press without resorting to the use of electricity. If, however, the electrical continuous separation can replace the filter press economically its use will be justified. At the present time no exact figures are available for purpose of comparison. To a large extent it would be a matter of the comparative economy of the electrical endosmose apparatus and the filter press.

(9) L. G. Hall's Investigation with Cement Slurry*

Hall gave the following "factors of the process":

(1) The opposite charges on the liquid and solid are probably due to the "electrical double layer," which is a purely surface effect; hence the efficiency of the process depends on the amount of surface exposed.

(2) The velocity of the particles approximates that of ions and increases with the voltage.

(3) The degree of dehydration is a function of the voltage.

(4) The amount of material moved is proportional to the amperage.

(5) The efficiency of the process is directly proportional to the fluidity. (NOTE: Hall used thick slurries. In the case of clay suspensions this may be true to a certain dilution. Beyond that point dilution decreases the efficiency.)

Hall describes the application of these factors and five electrophoresis machines in which the process can be applied. Most of these follow the rotating drum anode type of Schwerin.

He states that the completeness of unwatering is dependent on the voltage and nothing else. Thus, in experimenting with clay, he obtained a deposit which was very wet at 30 volts but at 1000 volts was very dry. There is an economic limit, however, to the voltage that can be used, due to the loss of current through electrolysis of the water at higher voltages. The current consumption is dependent upon two factors; the first of these

* Reference 67, p. 259.

is the amount of electrolyte present. Some electrolyte is necessary to increase the yield, but the amount should be maintained as low as possible to prevent loss of current through electrolysis of the water. A second factor is the viscosity. This can be lessened by the use of electrolytes or by raising the temperature of the suspension. Adsorbed air is also detrimental to efficiency of current consumption, but it can be released by the addition of electrolytes.

In comparing cement slurries with clay suspensions, Hall points out that they differ in that cement slurries contain two materials (clay and limestone) with opposite electrical tendencies. The clay tends to go to the anode while the limestone tends toward the cathode. Since, however, mutually adsorptive materials tend to go to the same pole, both the limestone and clay go to the anode unless the electric potential ruptures the adsorption bond. This is borne out by Bleininger's experiment with clay and ocher.*

An important factor in the efficiency of the process is the fineness of the particles. Clay particles approach colloidal sizes, but most of the limestone particles are much coarser and are apt to settle readily. This can be overcome by placing the electrodes in such a way that the one toward which the materials travel is at the bottom, thus securing the combined effect of the electrical difference of potential and of gravity.

A machine for large-scale unwatering of cement slurry which will meet the above conditions should have the following characteristics:

(1) Continuous operation.

(2) Electrical precipitation in a downward direction.

(3) Provision for intimate contact of the whole of the slurry, first with the upper cathode, then with the lower electrode (anode), taking the form of a gentle flow from the former to the latter.

(4) Provision for removing the precipitated solids from the liquid without violent washing action.

(5) Provision for draining the loose surface water from the solids after removal from the water.

(6) Provision for the escape of gases with as little disturbance as possible.

(7) A decreasing distance between the electrodes in the direction of flow of the liquid to compensate for the increased resistance of the latter as the amount of suspended matter decreases.

More details of Hall's experiments and those made in this laboratory will be given in a later paper.

(10) Investigations by V. S. Cartwright

V. S. Cartwright† conducted a brief general survey of the different methods of dewatering clay suspensions. The methods which he studied were: the filter press, the centrifuge, settling, electrophoresis, and heat methods, especially of the spray evaporator.

In his electrophoresis experiments, Cartwright used a stoneware jar for a container and two stationary brass electrodes. By this means he tried to determine the effects of (1) the time interval, (2) the spacing of the electrodes, (3) the rate of flow of fresh slip into the apparatus, (4) the con-

---

* Reference 61, p. 259.

† Reference 62, p. 259.

centration of the electrolytes. He experimented with suspensions of Mica (Washington) washed kaolin.

In regard to the four factors in electrophoresis named above, Cartwright concluded that

(1) The best length of run, when the deposit is allowed to collect undisturbed until the end of the interval, is between 1 and 25 minutes. He chose 10 minutes for subsequent tests.

(2) The optimum distance between electrodes was 2.5 centimeters.

(3) The lowest rate of flow of suspension used gave the most satisfactory results. (It is to be noted, however, that he used a very dilute clay suspension (11% clay).)

(4) Concentration of electrolytes; the most efficient deposition occurred when 0.05% sodium hydroxide was used. Acids decreased the yield.

Using the conditions determined as stated, and a clay suspension with 11.4% clay, Cartwright was able to obtain 8.03 pounds of clay per kilowatt hour and containing 35% moisture. Assuming that electric power could be secured for $30 per kilowatt year, he estimated that the cost of dewatering would be 85 cents per ton of clay treated.

Since Cartwright used an intermittent process, his yield was, of course, rather low. The copper electrodes he used dissociated strongly and contaminated the white clay on the anode so badly that it could not be used for fired white ware.

(11) Work of H. S. Davis H. S. Davis* continued the work of Cartwright and constructed an electrophoresis machine on the plan of Schwerin's patent U. S. 1,133,967. This machine

TABLE VII

RESULTS OBTAINED BY HOWARD S. DAVIS

Clay		Wt. defloc. per cent dry clay				Per cent water in dewatered clay	Wt. of dry clay per kw.-hr./sq. ft. anode/hr.	Notes
Kind	Suspension concentration (%)			Volts	Amperes			
Washington kaolin	30.1	Na_2SiO_3	0.1	81	3.2	100		Wt. of clay not taken
Florida kaolin	37.0	"	0.7	92	13.5	50	9.5 lbs.	
English china	46.3	"	0.4	24	7.5–10			Clay too wet to remove from drum
English china	32.6	"	1.5	33	16	100+		Too wet to remove

will be described in detail on a later page. Some of Davis' results with this machine and Mica (Washington) washed kaolin are given in Table VII. Davis arrived at the following conclusions:

(1) The success with which a clay may be dewatered by electrophoresis depends upon the nature of the clay itself. Thus plastic kaolins like Florida and Mica (Washington) kaolin lend themselves readily to the process, while English china clay could not be dewatered successfully by this electrophoresis equipment. The main reason for this difference probably lies in fineness of the clay particles; the finer-grained clays are apparently dewatered by the process more readily than coarse-grained ones.

* Reference 63, p. 259.

(2) Considerable pressure on the scraper is necessary for efficient removal of the dewatered clay when the machine is functioning properly.

(3) Covering the anode with a rubber jacket consisting of the inner tube of an automobile tire was not satisfactory with this machine. In fact, the flow of current was stopped entirely although a rubber coating over the anode is reported in use at Carlsbad.

II. Scope of Present Investigation

The present investigation was conducted with the following objects in view: First, to check the results obtained by V. S. Cartwright and H. S. Davis; second, to determine (1) which electrolyte or combination of electrolytes would give best results in the electrophoresis process with Mica (Washington) clay, (2) the effect of an increase of voltage, (3) the effect of increase of cathode area, and (4) the effect of the process on the hydrogen ion concentration of the suspension.

(1) Materials Used These consisted of Mica (Washington) kaolin and the following deflocculents: sodium silicate, sodium hydroxide, ammonium hydroxide, and gum arabic.

Mica* kaolin comes from a deposit in the eastern part of Washington located 16 miles southeast of Spokane at the town of Mica. The material is mined by the Gladding, McBean Company (formerly the American Firebrick Company) and is now used in the manufacture of fire brick. The kaolin is plastic enough as mined to be used alone in the stiff-mud brick machine.

The deposits may be classed as colluvial, that is, formed by a slight amount of transportation, perhaps nothing more than a hillside wash. Stratification in these deposits may be quite evident and coarse fragments of undecomposed feldspar are often found. They probably originated in the wash from surrounding areas of undecomposed feldspathic material, the fine clay being derived from kaolinitic deposits.....The rocks of this area are at least pre-Tertiary in age and consist of metamorphics intruded by granite rocks and their off-shoot dykes.†

(a) Sodium Silicate The manufacturers of the sodium silicate used in these experiments gave the following analysis of their products:

Analysis of the Sodium Silicate Used

Na_2O	6.4%
SiO_2	24.7%
Water	68.9%
Gravity	34° Bé

A test of this material in this laboratory showed a specific gravity of 1.308 and 32.2% of a solid material.

(b) Sodium Hydroxide The chemically pure material was used.

---

* An analysis of purified Mica (Washington) kaolin made by H. G. Schwartz is as follows: SiO_2 45.57, Al_2O_3 38.39, Fe_2O_3 1.37, MgO trace, ignition loss 13.47, giving a total of 98.80.

† Reference 104, p. 261.

(c) Gum Arabic A solution of gum arabic "sorts" in water was used.

(2) Preliminary Settling Tests The best dewatering efficiency with a given material is apparently obtained at that point where the material is most finely divided or "dispersed." Alkalis or alkaline salts are generally needed to produce this dispersion.

Preliminary to trying the effect of different electrolytes on the electrophoresis process, their respective actions on the rate of settling of suspensions of Mica (Washington) kaolin were somewhat roughly determined. The kaolin had been washed in this laboratory* without deflocculent and allowed to settle without the aid of a coagulating agent. The clay content was determined by drying a weighed sample.

In making the settling tests the samples were diluted to 0.3% clay content to reduce the opacity. The diluted samples were then placed in equally sized, graduated glass cylinders. The deflocculents were added in solutions of known concentration and in definite percentages of the dry clay weight. The mixture was well shaken and settled for four hours. If the material was well enough dispersed to remain in suspension for four hours, it would not settle to any large extent during the comparatively brief electrophoresis process. The results of the settling tests are given in Table VIII.

TABLE VIII

EFFECT OF DIFFERENT ELECTROLYTES ON THE SETTLING OF SUSPENSIONS OF MICA (WASHINGTON) KAOLIN

	Deflocculating action		Coagulating action		
Reagent	Range	Most active	Range	Most active	Highest concentration used
NaOH	0.05–5%	0.5%	5–10%	8.0 (?)	10%
Na_2SiO_3	0.05–90	0.5	None		90
NH_4OH	0.05–10	0.5	"		20
Gum	0.6–1.8	0.6–1.8	"		10
Gum + Na_2SiO_3	0.05–10	0.05–10	"		10
Gum + NaOH	0.6–1.8	0.6–1.8	"		10

The conclusions drawn from the above results are that Mica (Washington) kaolin consists in part of very fine particles which apparently remain in suspension for sufficiently long periods to permit electrical treatment without a deflocculent. A dispersion agent might be necessary, however, in order to increase the charges on the clay particles. Sodium silicate seemed somewhat more effective in low concentrations than the others and showed no coagulating action even at high concentrations. The action of ammonium hydroxide was similar, but somewhat less marked. Sodium hydroxide, on the other hand, produced marked dispersion at lower concentrations but produced flocculation at concentrations over 5% of the

* Reference 102, p. 261.

dry clay weight. Gum arabic appeared to exert a dispersing action at all concentrations, a condition which was apparently not affected by additions of sodium silicate or sodium hydroxide.

III. Electrophoresis Experiments

(1) Description of Apparatus

A diagram of the electrophoresis machine constructed by Howard S. Davis* is shown in Fig. 6. It consists essentially of a metal tank in which revolves a drum-shaped anode of type-metal (*A*). The latter is surrounded on the lower side by a laminated aluminum cathode (*B*). The presence of two different metals as electrodes produced in the presence of an electrolyte a cell-voltage of 2 to 3 volts. No harmful effects of this were observed but the small loss of current could be prevented by using the same metal in the two electrodes.

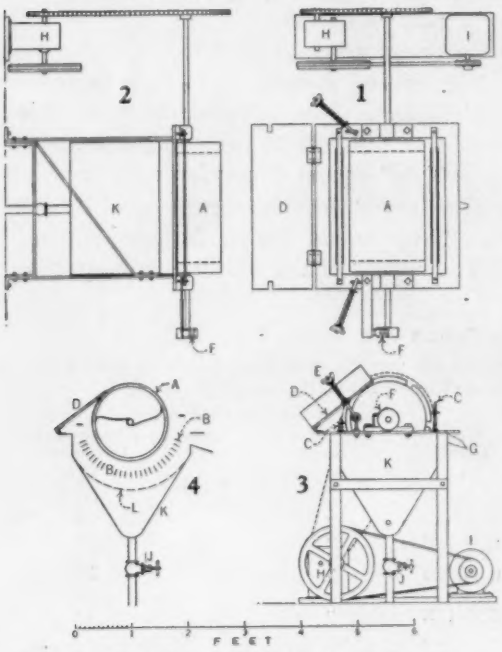


FIG. 6.—Experimental electrophoresis machine.

Both the anode and cathode are insulated from the rest of the machine. The cathode is hung from two metal rods, which in turn are supported by metal posts (*C*,*C*). The distance of the cathode from the anode is adjusted by means of nuts on these posts.

A small a.c. electric motor (*I*), working through a 1000 to 1 reduction gear (*H*), and a chain and sprocket, causes the anode to revolve slowly in a clockwise direction, as shown in the figure. The dewatered clay collects on the anode and is removed by the scraper (*D*), which may be placed under tension by means of the tension spring and screw (*E*). The speed of the motor is controlled by a rheostat shown in Fig. 7.

The direct current, after passing through an ammeter, enters the machine through a wire attached to the sliding anode contact (*F*), which is insulated from the body of the machine. The current passes in through

* Reference 63, p. 259.

the shaft on which the anode rotates, thence through wires from the shaft to the surface of the cylindrical shell of the anode, as shown in Part 3, Fig. 6. It is then conducted through the solution to the cathode and passes out through a wire attached to the cathode support (*C*).

Besides the difference in size, there are two main differences between this machine and the machines used at Carlsbad. One of these is the manner in which the suspension is fed into the machine. At Carlsbad the material enters through the bottom of the machine and overflows along the top. Two paddle wheels revolving in the bottom of the tank prevent settling and insure uniform flow of the suspension through the cathode. In the Seattle machine the clay suspension is introduced by a 12-inch copper trough attached to the cathode. This trough distributes the slip between the anode and cathode on the side opposite the outlet (*G*) for the full length of the machine. It was presumed that the particles would thus come at once under the influence of the electric field and would remain in the field for the maximum length of time, as the suspension tends to travel with the revolving anode toward the outlet. Later the partition, shown in Part 4, Fig. 6, at (*L*), was installed, which keeps the suspension within the field of the electrodes, decreases the amount of suspension necessary, and gives a means of cooling the machine by a flow of water in the space below the partition.

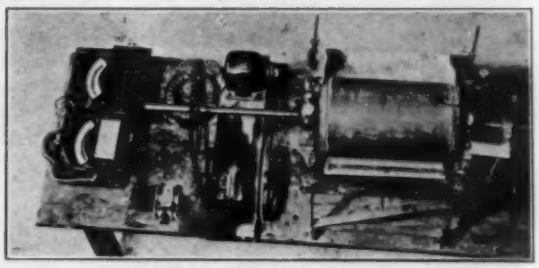


FIG. 7.—Laboratory machine and accessories (view from above). Electrical measuring instruments, driving motor, and reduction gear are visible at the left.

Another difference between this and the Carlsbad machines is that the latter are reported to have a covering of vulcanized rubber approximately 0.4 inch thick over the surface of the anode to facilitate the removal of the clay. How a current of 171 amperes at 103 volts can pass through the resistance offered by this has not yet been made clear to the writer. An attempt by H. S. Davis to simulate these conditions by covering the anode with a layer of rubber consisting of the inner tube of an automobile tire gave negative results. Consequently the anode was left uncovered. Little difficulty was encountered in removing the clay from the bare anode.

The machine is shown from above in Fig. 7. In this the cathode can be seen suspended below the drum anode. To the left of the machine are visible the driving motor, the reduction gear, rheostat, ammeter, and volt-

meter. In Fig. 8 the machine is shown connected in closed circuit with the Clarke-Kriegel laboratory clay-washing apparatus.*

(2) Preparation of Suspension for Electrophoresis The clay suspensions used in most of the experiments of this investigation were prepared as follows: The raw Mica (Washington) kaolin was washed in the laboratory apparatus shown in Fig. 8. No acid or alkali was added to assist in the washing and settling. After a settling

FIG. 8.—Laboratory electrophoresis machine in closed circuit with clay-washing apparatus.

period of 10 to 11 days in the storage vats, with occasional decantation, a suspension was obtained with a specific gravity of approximately 1.17. The dry clay content varied from 22.5 to 28.0% of the total weight. It should be noted, however, that the suspension thus obtained still contained the coarser clay particles, which are removed in the Carlsbad plant in the "schlicher" channels.

(3) Test Procedure In the majority of the tests the procedure was as follows: A well-mixed sample of the suspension was weighed out, placed in a galvanized-iron container, and agitated by

* Reference 102, p. 261.

bubbling air through it. The requisite amount of deflocculent was dissolved in a small amount of water and added slowly while the suspension was kept in agitation, just before the material was fed into the electrophoresis machine. This precaution was taken because it is commonly admitted that the time and method of adding the electrolyte have considerable effect upon its action. The container was placed eight feet above the dewatering machine and connected to the latter by means of a rubber hose. The suspension was run into the tank of the electrophoresis machine until it was overflowing in a steady stream before the current was turned on. The rate of feed varied from 71 to 846 g. per minute, with an average of 425 g. per minute.

After earlier experiments, with longer intervals, a 5-minute period was adopted as giving the best results. An average distance between the electrodes of 1 inch was maintained throughout the experiments.

Readings taken were as follows:

(I) Before starting.
- (*a*) Weight of dry clay per unit weight of suspension.
- (*b*) The hydrogen ion concentration or p_H value of the suspension. A colorimetric apparatus was used.

(II) During the experiment.
- (*a*) Ammeter and voltmeter readings. These were taken at the start and at 5-minute intervals thereafter.
- (*b*) Weight of dewatered clay produced. At the end of each 5-minute interval the clay which had collected during that interval was removed and weighed separately.
- (*c*) Temperature of the suspension in the machine. It was noted that the temperature of the suspension rose rapidly during the experiment; consequently thermometer readings were taken at the 5-minute intervals.

(III) At the end of the experiment.
- (*a*) Weight of depleted suspension.
- (*b*) Weight of unused suspension.
- (*c*) Per cent of dry clay in the depleted suspension.
- (*d*) Weight of dry clay produced. The samples of wet clay taken at the end of each 5-minute period were kept at approximately 110°C until completely dry and then weighed.
- (*e*) p_H value of depleted suspension and of dewatered clay.

(IV) Calculations.
- (*a*) Per cent of moisture in dewatered clay (wet clay basis); determined from weights of wet and dry samples.
- (*b*) Pounds of dry clay per kilowatt hour of power. In determining the amount of power consumed the voltage and amperage were taken as the average of the readings taken at the beginning and end of each period.
- (*c*) Pounds of dry clay per hour per sq. ft. of anode surface

(*d*) Pounds of dry clay per sq. ft. of total rotating surface per hour. Formula:

$$\text{Lbs./sq. ft./hr.} = \frac{\text{Lbs. dry clay per hr.}}{\text{Anode area (sq. ft.)} \times \text{r.p.h. of anode}}$$

(*e*) Pounds of dry clay per sq. ft. of anode surface submerged per hour. The portion of the anode area which was submerged in the suspension was equal to 36.3% of the total area. In the case of the Carlsbad machines this area was not known, but was estimated as one-third of the total area. The formula used was as follows:

$$\text{Lbs./sq. ft. submerged/hr.} = \frac{\text{Lbs. dry clay per hr.}}{\text{Area submerged (sq. ft.)} \times \text{r.p.h. of anode}}$$

IV. Experiments in the Dewatering of Mica (Washington) Kaolin

(1) The Influence of Some Different Electrolytes

In each run, as soon as the current was turned on, clay began to collect on the anode while bubbles were given off at the cathode. Since the cathode was located below the anode, these bubbles which consisted principally of hydrogen gas rose through the suspension until they touched the anode, where they adhered. The presence of a bubble prevented deposition of clay at that spot and, when the area was rotated to a point where it was exposed to the air, the bubble was broken, leaving a perforation in the coating of clay. With a high content of electrolyte this action was particularly noticeable and the clay coating was given a blotched appearance. At the same time the suspension around the cathode became noticeably watery while a coagulated suspension similar in appearance to sour milk collected behind the cathode. It was noted also that, when the suspension was passed through the machine too slowly to carry off the heat generated by the current, the temperature of the suspension rose rapidly to a maximum of 50 to 70°, depending on the conditions.

The results obtained without electrolyte are not exactly comparable to those of succeeding runs since the results with no deflocculent were obtained with a suspension containing 27.9% of dry clay per unit weight of suspension, while in the remaining runs a concentration of 22.5% of dry clay was used.

(2) Sodium Silicate Series

The per cent water in the clay obtained, the yield per unit of surface, and yield per unit of power for each concentration are given in Table IX. The results are shown graphically in Fig. 9.

The results indicate a small maximum in the yield per unit of surface and the yield per unit of power with a small amount of electrolyte. Later tests may show this maximum to be greater at a concentration between 0.05 and 0.2%. It would seem, however, that the product contains more

water at the lower concentration since the minimum water content was obtained at a concentration of 0.6%. At greater concentrations of electrolyte, the dryness of the product is not affected greatly but the yield is lowered.

TABLE IX

EFFECT OF SODIUM SILICATE ON THE ELECTROPHORESIS OF MICA (WASHINGTON) KAOLIN

Per cent electrolyte (dry clay basis)*	(m) Per cent water in product (wet clay basis)	(n) Pounds of dry clay/kw.-hr.	(p) Pounds of dry clay/sq. ft. of anode surface	No. of runs	Length of run (minutes)
†None	51.2	26.2	3.9	4	15
‡0.05	52.0	29.6	6.2	2	15
0.6	39.3	19.9	6.9	2	10
1.3	44.2	6.8	3.6	4	10
5.0	47.8	17.3	1.2	3	10

* Per cent of dry sodium silicate per unit of dry clay weight.
† Weight of dry clay 27.9% of total weight of suspension.
‡ Weight of dry clay in this and following readings was 22.5% of total weight of suspension.

(3) Sodium Hydroxide Series The sodium hydroxide results are shown in Fig. 10. The same small maximums in yield per unit of power and in per cent water in the product are shown at low concentrations, as in the case of sodium silicate. As the concentration of electrolyte is increased the product becomes drier, but there is a loss in efficiency of the current. The yield per unit of surface was uniformly low and not affected to any large extent by increase of sodium hydroxide. With a concentration of 5% electrolyte the results were negative, which confirms the results of the settling tests in which the suspension was found to be coagulated at this concentration.

TABLE X

EFFECT OF SODIUM HYDROXIDE ON THE ELECTROPHORESIS OF MICA (WASHINGTON) KAOLIN

Per cent electrolyte (dry clay basis)*	(m) Per cent water in product (wet clay basis)	(n) Pounds of dry clay/kw.-hr.	(p) Pounds of dry clay/sq. ft. of anode surface	No. of runs	Length of run (minutes)
†None	51.2	26.2	3.9	4	15
‡0.05	53.5	28.2	4.0	2	10
0.5	45.5	8.3	2.5	2	10
1.0	51.7	12.8	0.6	1	10
5.0	§100+	0.0	0.0	2	10

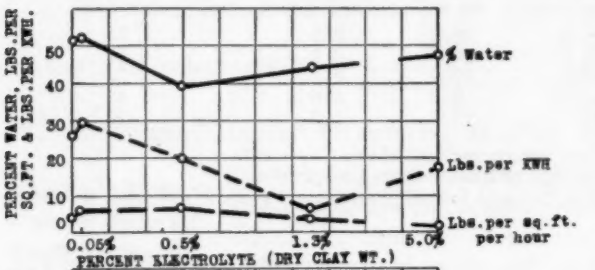
* Per cent of dry sodium silicate per unit of dry clay weight.
† 27.9% dry clay per unit weight of suspension.
‡ 22.5% dry clay per unit weight of suspension.
§ Clay coating was too wet to stick to anode.

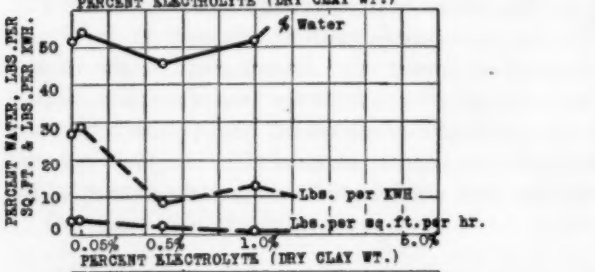
(4) Ammonium Hydroxide Series The graph of this series is shown in Fig. 11. The same small maximums in yield and in wetness of the product are shown at 0.05%

concentration, as in the previous tests. The water content of the product gradually decreases with increase of electrolyte in this case; also the yield per unit of power decreases while the yield per unit of surface is not greatly affected.

(5) Comparison of Results

The comparative importance of the degree of water reduction varies from different viewpoints. For example, if the process were to be used in a washing plant where dry clay is shipped to the market, the percentage of water remaining in the clay should be as low as possible. On the other hand, the process might be used in a whiteware plant in place of the usual filter-pressing and the object would be, not to obtain the driest clay possible, but to control the amount of dewatering so that the correct consistency of body could be produced for jiggering without further treatment. In any case, however, the efficiency of the process would likewise be dependent upon the other two factors, namely, the weight of clay produced per unit of power consumed and the weight of clay produced per unit of anode surface.





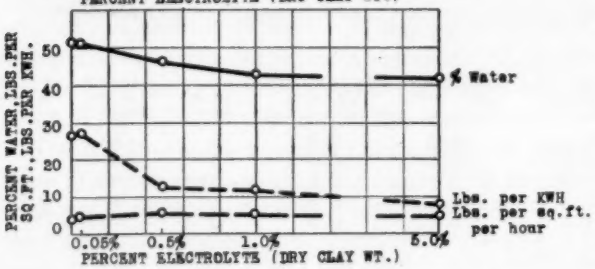


FIG. 9 (top).—Results with sodium silicate.
FIG. 10 (middle).—Results with sodium hydroxide.
FIG. 11 (bottom).—Results with ammonium hydroxide.

As a method of evaluating the results with the various concentrations of the different electrolytes given above, the following formula was used:

$$\frac{(n) \times (p)}{(m)} = (f)$$

In this formula, (m), (n), (p) represent the values given in the columns lettered correspondingly in the Tables IX, X, and XI. That is, the product of the yield per unit of power and the yield per unit of surface is divided by

TABLE XI

EFFECT OF AMMONIUM HYDROXIDE ON THE ELECTROPHORESIS OF MICA (WASHINGTON) KAOLIN

Per cent electrolyte (dry clay basis)*	(m) Per cent water in product (wet clay basis)	(n) Pounds of dry clay/kw.-hr.	(p) Pounds of dry clay/sq. ft. of anode surface	No. of runs	Length of run (minutes)
†None	51.2	26.2	3.9	4	15
‡0.05	51.1	26.6	4.5	2	10
0.5	46.4	12.2	5.8	2	10
1.0	42.1	11.1	5.5	2	10
5.0	41.6	7.8	4.2	2	10

* Per cent of ammonium hydroxide per unit of dry clay weight.
† 27.9% dry clay per unit weight of suspension.
‡ Weight of dry clay in this and following readings was 22.5% of the total weight of the suspension.

the per cent of water in the dewatered clay. Thus, an increase in the yield per unit of power or per unit of surface or a decrease in the amount of water in the clay from the machine will increase the value of (f). The most favorable conditions in general will, therefore, be indicated by the highest value of (f) under the given conditions.

A comparison of the values of (f) obtained in the preceding experiments is given in the following table:

TABLE XII

COMPARISON OF RESULTS WITH Na_2SiO_3, NaOH, AND NH_4OH

Concentrations, per cent dry clay weight		(f) values: Sodium silicate	Sodium hydroxide	Ammonium hydroxide
0.00		2.00	2.00	2.00
0.05		3.53	2.11	2.34
0.5	*(0.6%)	3.50	0.46	1.53
1.0	†(1.3%)	0.55	0.15	1.45
5.0		0.43		0.79

* A concentration of 0.6% dry clay weight used in this reading.
† A concentration of 1.3% used in this reading.

The values in the above table are shown graphically in Fig. 12.

The above data indicate that sodium silicate gave better results than the other electrolytes, especially at the lower concentrations, which is, of course, highly desirable from the standpoint of cost of electrolyte. The conclusion that a low concentration of sodium silicate gives best results evidently coincides with the experience of the Carlsbad company, where

approximately 0.1% sodium silicate is used. MacDowell* found that sodium silicate had a greater effect on the viscosity of clay slips than NaOH or Na_2CO_3 and that its effect increased most rapidly at low concentrations. Bogue** found that sodium silicate is more highly hydrolyzed at low than at high concentrations, which may account for its greater effect in electrophoresis at low concentration.

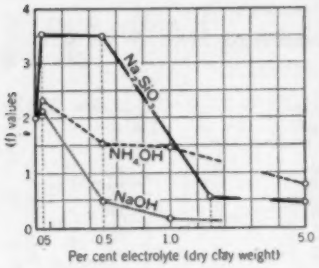


FIG. 12.—Comparison of (*f*) values.

Ammonium hydroxide appears to be better than sodium hydroxide, since it gives as good or better results at all concentrations. Two disadvantages in the use of NH_4OH are its disagreeable odor and its high cost. At the market quotations of May, 1930, the prices of equivalent amounts of NH_4OH, NaOH, and Na_2SiO_3 are approximately in the ratios of 400 to 3 to 1.

From the above results it was decided to use sodium silicate as deflocculent for the remainder of the experiments, and a concentration of 0.5% of the dry clay weight was adopted. Observations thus far seemed to warrant the conclusion that the fastest rate of feed under the given conditions was conducive to best results. Accordingly, the overflow was maintained at 396 to 700 grams per minute with an average of 550 grams per minute during the remainder of the experiments.

V. The Effect of a Small Increase of Voltage on the Efficiency of Dewatering Mica (Washington) Kaolin

The results of previous investigations indicate that an increase of voltage results in a drier product. Thus Searle† states: "The density of the deposited matter depends on the voltage." L. G. Hall gives the following results which he secured with a simple electrophoresis cell and a fine grade of fire clay.‡

TABLE XIII

EFFECT OF VOLTAGE ON THE COMPLETENESS OF UNWATERING AS REPORTED BY L. G. HALL

Voltage	Time	Per cent water in product	Thickness of coating	Characteristics of coating
30	1 hr.	?	3/8 inch	Too soft to be withdrawn from suspension
220	10 min.	15	3/8 inch	Fairly firm
1000	5 min.	5	1/2 inch	Force necessary to remove it from anode

Hall points out, however, that at the higher voltages the efficiency may be lower, due to the increased loss of current in the electrolysis of the water.

* Reference 26, p. 258.
** Reference 5, p. 257.
† Reference 105, p. 261.
‡ Reference 67, p. 259.

It was not possible at this time to secure the wide range of voltage recorded by Hall. During the majority of the experiments the line voltage was 103. As the conductivity of the suspension increased, the voltage through the machine rapidly decreased due to the small capacity of the

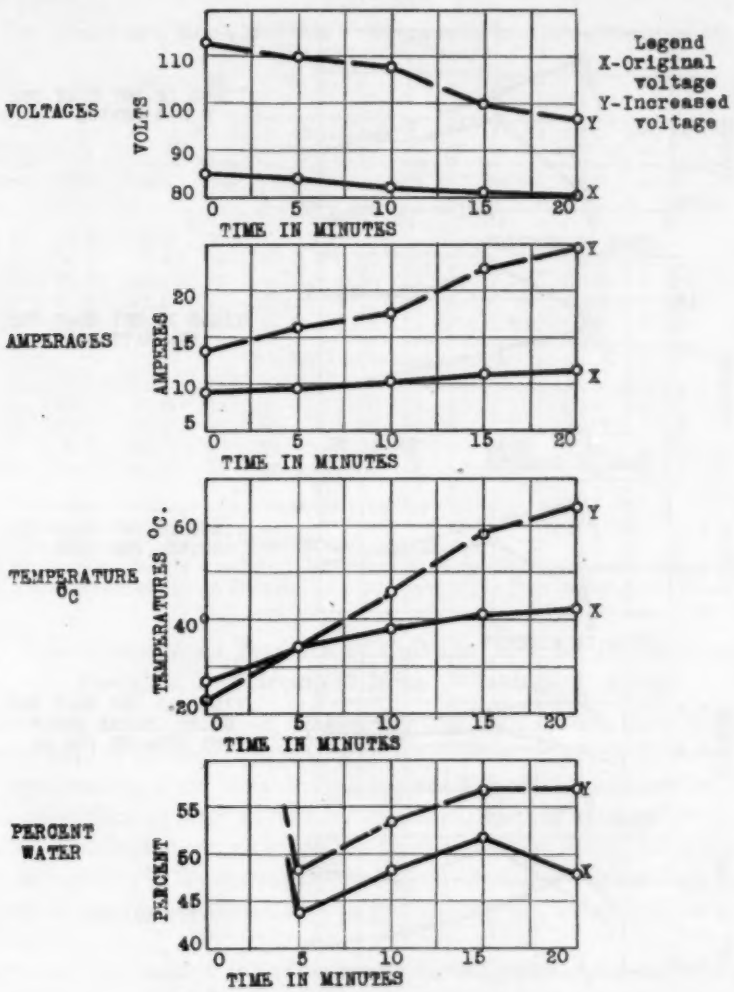


FIG. 13.—Effect of increase of voltage.

generator used. Later the line voltage was raised to 132 and the voltage through the machine then only dropped to a value varying between 80 and 100 in the course of a given run. The voltage used at Carlsbad is about 103,* but this is probably maintained at a constant value. In the

* Reference 68, p. 259.

experiment noted by Hall (Table XIII) the voltage was increased first to seven times and then to 33 times the original voltage, while in this experiment the increase was only about one-fourth of the original voltage. Consequently the striking results obtained by Hall could not be expected.

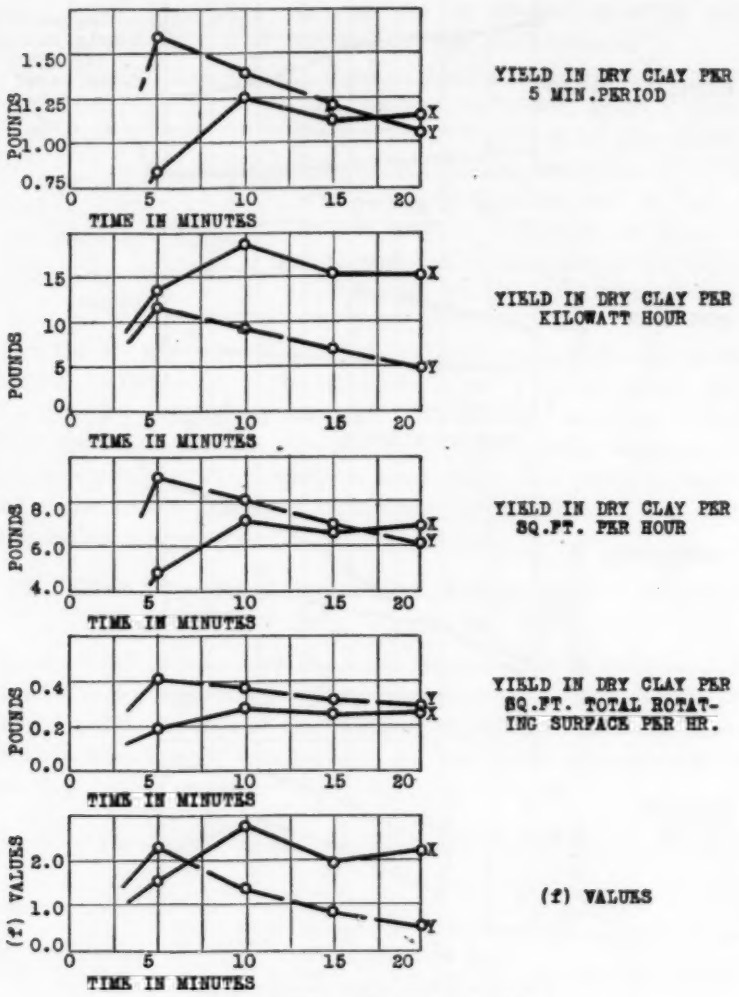


FIG. 13*a*.—Effect of increase of voltage.

A run was made, using a suspension containing 22.5% of dry clay at a rate of 545 and 396 grams per minute. The results are given in Table XIV and in Figs. 13 and 13*a*.

It will be seen that there is some gain in the yield per unit of surface, but

a smaller yield per unit of power and a loss in the dryness of the product by the use of the increased voltage. The (*f*) values give a higher rating to the run with the lower voltage.

TABLE XIV

THE EFFECT OF A SMALL INCREASE IN VOLTAGE ON THE DEWATERING OF MICA (WASHINGTON) KAOLIN

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Time (minutes)	Volts	Amps.	Temp. °C	Per cent water in product (wet clay basis)	Yield in dry clay/5 min. (lbs.)	Lbs. dry clay/kw.-hr.*	Lbs. per sq. ft.† per hr.	Lbs. per sq. ft. total rotating surface per hr.	Lbs. per sq. ft. submerged‡ per hr.	(*f*) values§
				A—With original voltage						
0	85.0	8.2	27§							
5	84.0	9.5	34	43.9	0.85	13.65	4.88	0.19	0.52	1.53
10	82.0	10.1	38	48.2	1.26	18.60	7.20	0.28	0.77	2.73
15	81.0	11.0	41	51.5	1.13	15.75	6.46	0.25	0.69	1.92
20	80.0	11.5	42	47.8	1.16	15.38	6.65	0.26	0.72	2.14
				B—With increased voltage						
0	113	13.5	23§							
5	110	16.0	34	48.1	1.60	11.69	9.15	0.42	1.16	2.22
10	108	17.5	46	53.4	1.40	9.20	8.02	0.37	1.02	1.38
15	100	22.5	58	56.7	1.22	7.04	6.97	0.32	0.88	0.86
20	97	24.5	64	56.8	1.06	4.98	6.09	0.28	0.77	0.53

* Average of voltage and amperage readings at beginning and end of each period used in computing kw.-hr.

† Dry clay per sq. ft. of cylindrical surface of anode.

‡ Since this is merely a multiple of column No. 9. the results are not shown on a graph.

§ Average rate of feed in Part A, 545 g. per minute; in Part B, 396 g. per min.

VI. The Effect of an Increase of Cathode Area on the Efficiency of Electrical Dewatering of Mica (Washington) Kaolin

Schwerin stated in U. S. Patent 1,133,967 that "the electro-osmotic process may be enhanced considerably in efficiency by giving the suspension an opportunity, when it is flowing toward the anode, to wash against a cathode surface as large as possible in comparison with the anode surface, so that the suspension is subjected to the cathode action on a path as long as possible." By increasing the cathode surface, "the current density is increased, which is advantageous, particularly in the osmotic treatment of clay."

The cathode used in the experiments to this point consisted of a sheet of aluminum approximately $^1/_{16}$ inch in thickness. In this were punched round holes $^1/_2$ inch in diameter and 2-inch intervals in staggered rows 1 inch apart. The total area of this cathode, including both sides and the edges of the holes, was 271.4 sq. in. The object of the holes was to permit circulation of the suspension through the cathode.

As a means of verifying the statement quoted above from Count Schwerin a cathode was constructed as follows: Sheet aluminum $^1/_{16}$ inch thick

was cut into strips $^3/_4$ inch wide and 1 foot long (the length of the anode). These strips, placed with their surfaces parallel, with washers of the same material for spacers, were drilled and hung on three metal rods which had been cut to form an arc of a circle with 1 inch greater radius than that of the anode. This cathode was suspended from insulated supports on the electrophoresis machine (*c*, Fig. 6) and the height adjusted until it was at the desired distance from the anode and parallel to it. A comparison of the dimensions of these cathodes is given in Table XV.

TABLE XV

COMPARISON OF THE GRID CATHODE WITH PERFORATED SHEET CATHODE

	Sheet cathode	Grid cathode
Area	271.4 sq. in.	1732.4 sq. in.
Relative areas	1	6.38
Area of submerged portion of anode	110.0 sq. in.	110.0 sq. in.
Ratio of cathode areas to area of submerged portion of anode	Anode: cathode 1 : 2.46	Anode: cathode 1 : 15.7

With this grid cathode in place, a suspension of 22.5% dry clay and containing 0.5% sodium silicate was used. The results of one run are given in Table XVI and Fig. 14.

TABLE XVI

THE EFFECT OF INCREASE OF CATHODE AREA READINGS WITH GRID CATHODE*

(1) Time (minutes)	(2) Volts	(3) Amps.	(4) Temp.† °C	(5) Per cent water in product (wet clay basis)	(6) Yield in dry clay per 5 min. (lbs.)	(7) Lbs. dry clay/ kw.-hr.‡	(8) Lbs. per sq. ft. per hr.§	(9) Lbs. per sq. ft. total rotating surface per hr.	(10) Lbs. per sq. ft. submerged per hr.	(11) (*f*) values
0	110	10.0	23							
5	102	16.0	34	47.6	1.65	14.38	9.45	0.43	1.18	2.85
10	96	19.0	43	43.8	1.50	10.39	8.60	0.39	1.07	2.04
15	98	18.5	45	46.0	1.72	11.35	9.84	0.45	1.24	2.42
20	90	24.0	45	49.3	1.70	10.21	9.68	0.44	1.21	2.00

* For sheet cathode readings used in graphs for comparison see Table XIV B.
† Average rate of feed during this run, 702 g. per min.
‡ The average voltage and amperage for each 5-min. period used.
§ Per sq. ft. of cylindrical surface of anode.

The temperature did not rise as high with the grid as with the plane cathode because of the increase in the rate of feed to 702 grams per minute. It will be seen that the grid cathode gives somewhat better results in all of the other figures except in the dryness of the deposit obtained. The (*f*) values give the grid cathode a better rating, but the difference in results with the two cathodes is not marked. Two considerations, however, might warrant the use of the grid cathode in commerical practice. One of these is that the increase in efficiency obtained with it in these experiments might be proportionally greater in a larger machine. The other is that, with

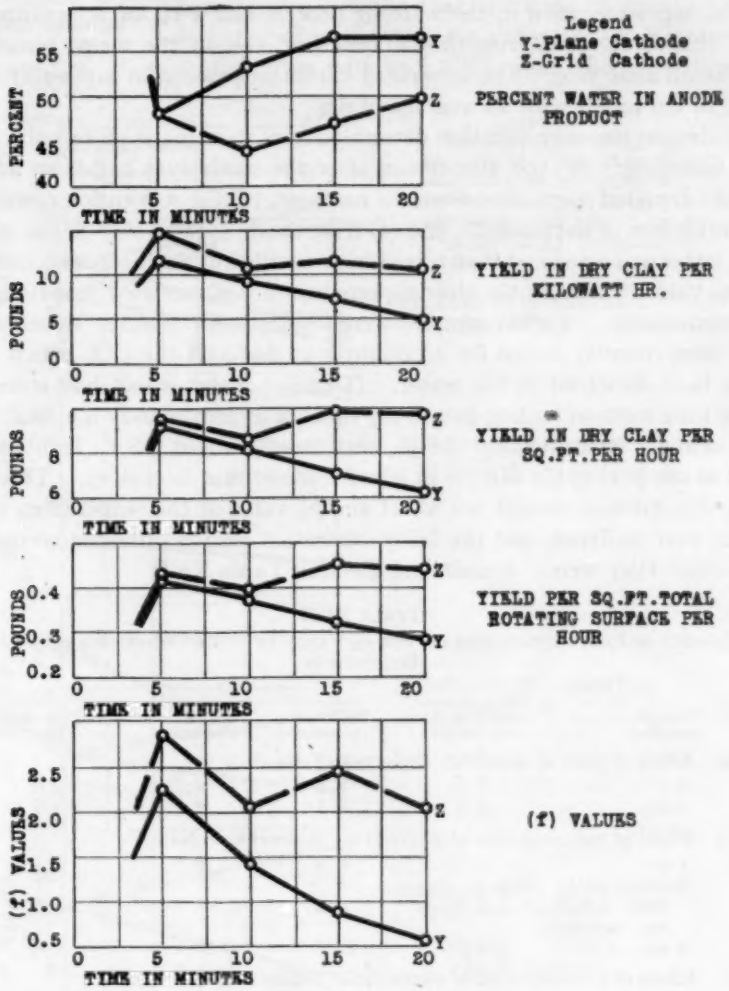


FIG. 14.—Effect of increase of cathode area.

better contact between suspension and cathode than was obtained in this experiment, the effect of the increase in area might become more apparent.

VII. The Effect of Electrophoresis on the p_H Values of the Products

(1) Method of Procedure

The determination of the hydrogen ion concentration offers a possible method of control of the electrophoresis process, since it indicates the state of dispersion of the suspension and offers a method for noting the changes which take place during the process.

The tap water used in the washing process had a p_H of approximately 7.5; this value varied from time to time but was, in the main, somewhat on the alkaline side. The unwashed kaolin suspension in tap water gave a p_H of 6.6 to 7.3 with an average of 6.8.

Hydrogen ion concentration determinations were made on samples from the following: (1) the suspension after the electrolyte had been added, (2) the depleted suspension from the machine, (3) the suspension remaining in the bottom of the machine, and (4) from the dewatered clay on the anode. The latter was dried and then mixed with distilled water before determining its p_H value. Usually the clear supernatant liquid was used in making the determinations. Turbid samples were diluted with distilled water which had been recently boiled for 15 minutes to drive off the CO_2 which may have been dissolved in the water. (Distilled water which had stood for some time without boiling gave a p_H value of approximately 6.5, that is, it was acidic. After boiling, the p_H was usually about 6.8.) Dilutions as high as one part of the sample in 50 were sometimes necessary. Theoretically this dilution should not affect the p_H value of the suspensions if the latter were buffered, and the fairly consistent results obtained seemed to show that they were. Results are given in Table XVII.

TABLE XVII

EFFECT OF ELECTROPHORESIS ON THE p_H VALUE OF MICA (WASHINGTON) CLAY SUSPENSION

Time of standing	Per cent electrolyte to dry clay weight	p_H Values: Before electrophorizing	Depleted suspension	Recovered clay*	
(*a*) Effect of time of standing: deflocculent–Na_2SiO_3					
0	0.5	8.2	8.7	6.6	
2 mo.	0.5	8.1	9.7	6.7	
(*b*) Effect of concentration of electrolyte; deflocculent–Na_2SiO_3					
4 mo.	0.05	6.6	†	6.4	
Average of 4 runs, 0 to 2 mo. standing	0.5	8.2	8.9	6.6	
4 mo.	5.0	10.6	10.7	6.9	
(*c*) Effect of concentration of electrolyte; deflocculent–NaOH					
3¾ mo.	0.05	7.2	6.6	6.6	
3¾ mo.	0.5	10.2	10.3	†	
3¾ mo.	5.0	11.2	11.2	†	
(*d*) Effect of concentration of electrolyte; deflocculent–NH_4OH					
3¾ mo.	0.05	7.6	8.4	6.8	
3¾ mo.	0.5	10.0	10.2	7.1	
(*e*) Effect of mixture of NaOH (0.05%) and Na_2SiO_3 (0.5%)					
2 mo.	0.05 and 0.50	8.4	9.6	6.7	
(*f*) Readings from various parts of the machine; deflocculent–Na_2SiO_3					
0	0.5	8.2	8.6	6.5	‡8.5
0	7.3	8.2	8.7	6.6	‡8.2

* Suspended in boiled distilled water.
† Reading not taken.
‡ p_H of suspension in bottom of machine at end of process.

(2) Conclusions These results indicate that the time of standing had but little effect on the p_H values. An increase in concentration of electrolyte from 0.05 to 0.50% raised the p_H values as

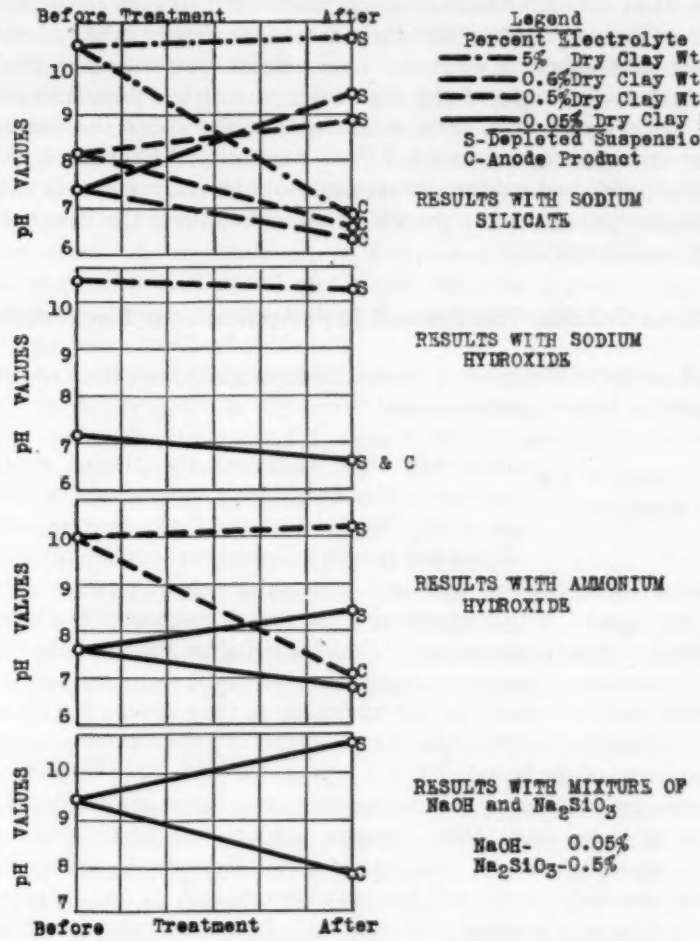


FIG. 15.—Effect of the process on the p_H values of the suspension.

follows: sodium silicate, 1.6 points, ammonium hydroxide, 2.4 points, and sodium hydroxide, 3.0 points.

This agrees with the results of the settling tests, in which the effect of an increase of NaOH was much more apparent than in the case of the silicate or ammonium hydroxide. The NaOH produced flocculation at 5.0% concentration, while the other electrolytes could not be made to produce this effect even at high concentrations. Likewise, in the electrophoresis

process the action of NaOH was much more radical than that of Na_2SiO_3 and NH_4OH. Thus, while Na_2SiO_3 and NH_4OH gave poorer results at a concentration of 5.0% than at lower concentrations, the clay obtained with NaOH at the higher concentration was too wet to stick to the anode.

The most striking result of the above data is the change in the p_H values during the electrophoresis process. This is shown particularly in Fig. 15. Almost invariably the p_H of the depleted slip is higher than that of the original suspension. Also, with one exception, the p_H of the recovered clay has dropped slightly below 7.0, or neutrality. A mixture of the sodium hydroxide and sodium silicate has about the same effect as sodium silicate alone would have at a concentration of the sum of the two, that is, at 0.55% concentration.

VIII. Some Colloidal Theories and Their Application to Electrophoresis

A brief review will be given of several theories which have been advanced to explain the following phenomena:

(1) The Cause of the Orginal Electrical Charge

Michaelis* has advanced the theory that, in materials like clay, some molecules may dissociate into free H^+ ions and long, complex anions. The latter remain attached to the colloidal particles or "micellae" in such a way that the free negative valence extends outward toward the liquid. This gives the original negative charge. It also coincides with Bradfield's conclusions** that the colloidal clay particles have a weak acid reaction. Another viewpoint is given by Langmuir† and Harkins‡ whose work indicates that the molecules at the surface of a liquid so arrange themselves that the majority have similar poles turned away from the main body of the liquid. If this is true, the molecules of water adsorbed onto the surfaces of the clay particles may be so arranged that the majority of them have their negative poles outward, giving the clay particle a negative charge. (See Strickler and Mathews.)§ Freundlich's "preferential adsorption theory" is allied to the above ‖. Colloidal particles may have the ability to adsorb a specific kind of ion under given conditions, but the kind of ion adsorbed may be influenced by a change of conditions, such as temperature, concentration of the ion, etc.

---

* Reference 30, p. 258.
** References 7 to 12, p. 257.
† Reference 22, p. 257.
‡ Reference 20, p. 257.
§ Reference 37, p. 258.
‖ References 18, 3, 4, 43 to 46, pp. 257 and 258.

(2) The Action of Bases Bole* assumes that the clay particle has an original negative charge and is thus able to adsorb onto its surface a coating of positively-charged colloidal material of unknown composition. This coating of colloidal material may be removed by added bases, thus forming an "OH-colloid complex." The gradual removal of this coating by small additions of a base leaves many particles smaller in size and negatively charged. Both of these factors would tend to cause a separation or dispersion of the clay particles. If, however, a large amount of NaOH is added, the positive coatings are completely removed, giving the negatively-charged particles an opportunity of uniting with the Na^+ ions to form a neutral body with resulting coagulation or flocculation. Again, according to the preferential adsorption theory, it may be possible that the adsorption for OH^- ions is greater than that for Na^+ ions at low concentrations of the electrolyte, with the reverse true at larger concentrations of NaOH.

It has been pointed out by McDowell† that since the OH^- ion is apparently the active agent in dispersion, an equivalent weight of Na_2O in sodium hydroxide, which is highly ionized, should have a relatively greater effect than an equivalent weight of Na_2O in sodium silicate. But this has not been found by McDowell to be the case. Accordingly, he supplements Bole's theory by assuming that when sodium silicate is dissolved in water, it hydrolyzes to form colloidal silica which adsorbs some of the Na^+ ions, thus leaving the OH^- more active. Schwerin (U. S. Patent 993,888) thought that colloidal silicic acid was formed by the hydrolysis of the silicate and that this is adsorbed by the clay micellae. Being strongly electro-negative, the adsorbed silicic acid would thus increase the charges on the clay particles.

(3) The Action of Acids The coagulating effect is caused by the hydrogen ions which drive more of the positive colloidal material into the outer coating or are adsorbed themselves onto the clay particles. The charges are completely neutralized and the particles can then cohere to form comparatively large clots or groups. It would seem that with an excess of H^+ ions, these would be driven onto the clay particle to produce a positive charge. No clays of this study, however, could be made to travel to the cathode or act as if they were positively charged. The equilibrium produced by the positive layer is not unbalanced by the electric force.

(4) Electrophoresis Theories When the electric current is sent through a clay suspension dispersed with NaOH, the clay particles travel to the anode, the sodium ions go to the

---

* Reference 6, p. 257.

† Reference 26, p. 258.

cathode, give up their charges, and unite with water to form NaOH again. Hydrogen from the water or from the excess hydrogen ions discharged at the cathode is therefore liberated as bubbles at the cathode. The reunited NaOH together with the neutral "OH-colloid complex" of Bole should then be swept out with the overflow, and both should be more concentrated in the depleted slip than in the original suspension. The alkalinity of the depleted suspension is increased as shown in Table XXII and Fig. 15. Partial analyses of the depleted slip did not indicate any change in composition from the original suspension. Even though Bole's "OH-colloid complex" is formed, it may be swept to the anode by the mass action of the clay particles.

The clay particles having given up their charges at the anode should have a lower p_H value than that of the entering suspension. This is shown in Table XXII and Fig. 15. The clay particles at the anode collect in large clots in a nearly neutral condition. The destination or final form of the liberated and discharged hydroxyl is not known.

Most clay particles in the original condition as mined are in a weakly coagulated condition, have p_H values slightly below 7, and do not respond as readily to electric stress as they do after having been dispersed by alkali. The increased response may be due to the removal of the positive film by the base or to the mechanical dispersion of large clots, whose mass is too great for movement through the liquid by the electric force, into smaller particles with active, negative surfaces whose mass or bulk can be easily handled by the electric force available.

Helmholtz* has given a theory to explain the cause of particle movement under electrical stress. The distribution of charges is such that the surface of the solid is charged oppositely to the more or less mobile layer of liquid next to it. This orientation of charges gives rise to an "electrical double layer." An electrical difference of potential cannot move the solid particles and its layer as a whole, because taken together they form an electrically neutral and perfectly balanced body, but "the electric force will tend to bring about a displacement, relatively to each other, of the positively-charged fluid layer and the negatively-charged particle, whereby the fluid layer follows the flow of positive electricity while the particle moves in the opposite direction. If the liquid were a perfect insulator the new position would still be a condition of equilibrium. Since, however, through the displacement of the layers the equilibrium of the galvanic tension between the solid particle and the liquid is disturbed, and on account of the fact that the conductivity of the liquid always seeks to restore itself, the original state of electrical distribution will tend to be continually reproduced and so new displacements of the particle with respect to the surrounding liquid will continually occur."*

* Reference 54, p. 259.

IX. Summary

(A) Comparison of Some Factors of the Electrophoresis Process at Carlsbad with Present Investigation

In the following series of tables a compilation is made of the different factors of the process at Carlsbad as given by Hind* or calculated from the data which he gives. For purposes of comparison a similar compilation is given of factors and results obtained thus far at the Northwest Experiment Station of the U. S. Bureau of Mines.

TABLE XVIII

ANALYSES OF RAW KAOLIN USED

	Carlsbad Reported by Hind* (%)	Carlsbad Reported by Meyer (%)		Mica (Wash.) kaolin (%)
Sand	64	64.3	Coarse sand	45.5
Schlicher clay	12	10.7	Fine sand and mica	16.2
Osmosis clay	24	25	Clay	38.2

* Reference 68, p. 259.

TABLE XIX

COMPARISONS OF SUSPENSIONS USED

	Carlsbad	Univ. of Washington
Particle size	Finest kaolin	Coarse and fine kaolin
Deflocculent (dry clay basis)	Sodium silicate 0.12%	Sodium silicate 0.5%
Specific gravity of suspension	1.22	1.17
Rate of feed (U. S. liq. gal./hr.)	1584	0.22
Gal./sq. ft. of anode surface/hr.	2.9	0.004
Per cent water in entering dry clay wt. basis	*59.8% †70.7	77.5%

* Using volume of entering slip equal to 5.6 cu. m. per machine per hr. (Hind, reference 68, p. 259).

† Using volume of entering slip equal to 7.7 cu. m. per machine per hr. (Hind, reference 68, p. 259).

Method of calculation of per cent water in entering suspension.

NOTE: One tonne equals 1000 kg. = 1.1 T. of 2000 lbs.

Given: (Hind,* reference 68, page 259)

Composition of anode product	Clay	65%	
	Water	35%	
Weight of clay in anode product per 24 hrs. per 6 machines			19.38 tonnes
Volume of entering suspension per machine	tested (A)		5.6 cu. m./hr.
	calculated (B)		7.7 "
Specific gravity of entering suspension			1.22
Wt. of edelkaolin per 6 machines per 24 hrs.			396 tonnes

Calculations:

(A) Wt. of entering suspension per 6 machines per 24 hrs. (See A above)

$5.6 \times 6 \times 24 \times 1.22 =$ 983.4 tonnes

Composition of entering suspension

$\frac{396}{983.4} \times 100$	Clay	40.2%
100 − 40.2%	Water	59.8%

(B) Using 7.7 cu. m. per hr. of entering suspension the above calculation gives:

Clay	29.3%
Water	70.7%

TABLE XX

COMPARISONS OF MACHINE SPECIFICATIONS

	Carlsbad machines (reported by Hind)	Univ. of Wash. machine
Revolving anode		
Material	Hard lead-rubber covered	Type metal
Length (ft.)	4.7	1.0
Diameter (ft.)	2.03	0.665
Circumference (ft.)	6.39	2.09
Area of cylindrical surface (sq. ft.)	30.0	2.09
Ratio of cylindrical surfaces of machines	14.4 to	1.0
Area of submerged portion of anode (sq. ft.)	10.0 (*i.e.*, approximately 1/3 of total)	0.76 (= 36.3% of total area)

		Range	Usual
Speed of rotation (rev./hr.)	18	16–27	26
Peripheral speed (ft./hr.)	115.2	33.4–56.5	54.4
Total rotating area (sq. ft./hr.)	540	33.4–56.5	54.4
Rotating area submerged (sq. ft./hr.)	180	12.1–20.6	19.6

TABLE XXI

COMPARISONS OF ELECTRIC CURRENT CONSUMPTION

		University of Washington			
	Carlsbad (reported by Hind)	With original voltage Range	Average	With increased voltage Range	Average
Voltage	103	73.0–88.0	79.2	85.0–113.0	101.8
Amperage	171	8.2–14.0	11.0	10.0–24.5	18.7
Amperes/sq. ft. anode surface	5.7	3.9–6.7	5.3	9.8–11.7	8.9
Power consumption/machine (kw.-hr.)	17.6	0.69–1.08	0.92	1.10–2.38	2.11
Power consumption/sq. ft. anode area/hr. (kw.-hr.)	0.59	0.33–0.52	0.44	0.53–1.14	1.01
Power consumption/sq. ft. total rotating surface/hr.* (kw.-hr.)	0.033	0.01–0.03	0.017	0.02–0.07	0.039
Power consumption/sq. ft. submerged/hr.† (kw.-hr.)	0.099	0.03–0.08	0.05	0.06–0.19	0.11
Amperes/sq. ft. submerged‡	17.1	5.13–8.82	6.97	12.9–15.4	11.7

* Method of computation: kw.-hr. divided by (anode area × revolutions per hour).
† " " " " " by area of submerged portion of anode.
‡ " " " amperes divided by area of submerged portion of anode surface.

TABLE XXII

COMPARISONS OF YIELDS FROM ELECTROPHORESIS MACHINES

	Hind		University of Washington			
	Reported at Carlsbad	Calculated	With original voltage Range	With original voltage Average	With increased voltage Range	With increased voltage Average
Yield in dry clay/machine /hr.-lbs.	549.8	442.0	9.4–15.0	12.8	12.6–20.5	16.7
Dry clay/sq. ft. anode surface/hr.-lbs.	18.3	14.7	4.5–8.0	6.4	6.0–9.8	8.0
Lbs. dry clay/sq. ft. total rotating surface/hr.	1.02	0.82	0.173–0.31	0.24	0.23–0.38	0.31
Dry clay/sq. ft. submerged/hr.	3.06	2.46	0.48–0.85	0.66	0.63–1.05	0.85
Per cent water in clay from machines	35.0	35.2	42.2–57.9	48.3	43.8–56.8	49.8
Per cent water reduction on wt. basis of water in entering suspension	63.8 77.8		78.7–60.9	73.7	77.8–62.7	72.1

Method of calculation of per cent water reduction:

Given:

Composition of anode product { Clay 65%, Water 35%

Calculations:

Composition of entering suspension (See under A, Table XIV, page 245) { Clay 40.2%, Water 59.8%

Tons of water carried by 65 tons of clay in entering suspension:

$$\frac{65 \text{ T.}}{40.2} \times 59.8 = 96.6 \text{ T.}$$

Per cent water reduction on basis of original water content:

$$\frac{96.6 \text{ T.} - 35 \text{ T. (to 100 T. anode product)}}{96.6} = 63.8\%$$

TABLE XXIII

COMPARISONS OF YIELD IN DRY CLAY PER UNIT OF POWER

	Hind		University of Washington			
	Reported at Carlsbad	Calculated	Original voltage Range	Original voltage Average	Increased voltage Range	Increased voltage Average
Kw.-hr./ton* of dry clay	64.5	†79.6	129.8–146.5	137.5	176.5–232.4	252.2
Tons of dry clay/kw.-hr.	0.016	‡0.013	0.008–0.007	0.007	0.006–0.004	0.004

* Short tons of 2000 lbs.

† Singer gives 42.8 kw.-hr. per T. as a common value for this (reference 84, p. 260).

‡ Singer gives 0.023 as a common value for this (reference 84, p. 260).

TABLE XXIV

COMPARISONS OF COST IN ELECTRIC POWER PER TON OF DRY CLAY

	Hind		University of Washington			
			Original voltage		Increased voltage	
	Reported at Carlsbad	Calculated	Range	Average	Range	Average
At English price of 2 ¢./kw.-hr.	$1.29	*$1.59	$2.60 to $2.93	‡$2.75	$2.53 to $4.65	$4.04
At Carlsbad 1 ¢./kw.-hr.	0.645	0.796	1.30 to 1.46	1.37	1.76 to 2.32	2.02
At Seattle 0.6 ¢./kw.-hr.†	0.387	0.478	0.78 to 0.88	0.82	1.06 to 1.40	1.21

* Ormandy gives an estimated range of $0.08 to $0.54 per ton (reference 77, p. 260).

† Probably a lower rate than this could be obtained with the large amount of current consumption which would be necessary.

‡ Cartwright (reference 62, p. 259) estimated the cost per ton with current at $30 per kilowatt year as $0.85.

X. Conclusions

The above experiments indicate that, in the treatment of suspensions of Mica (Washington) kaolin, the following results are found:

(1) The concentration of electrolyte which gives the maximum dispersion determined by settling tests agrees approximately with the concentration which gives the best results in electrophoresis.

(2) A certain degree of dewatering can be obtained by using a suspension to which no deflocculent has been added but a deflocculent seems to be necessary for efficient dewatering. Of the deflocculents tested, sodium silicate gave better results than sodium hydroxide or ammonium hydroxide. The best results with Na_2SiO_3 were obtained when the concentration of dry silicate was 0.6%, or lower, of the weight of the dry clay in suspension. Five per cent NaOH produced coagulation.

(3) The effect of increasing the cathode area by the use of laminated sections produced but little change.

(4) In most cases electrophoresis raised the indicated hydrogen ion content of a dispersed suspension, but lowered the p_H of the clay which collected on the anode to neutrality or below.

(5) The cost of electricity in terms of direct current at 1 cent per kilowatt hour, and with the maximum efficiency attained with the present machine, would be $1.30 per ton of dry clay. With the efficiency attained at Carlsbad it is calculated that the cost would be between 65 and 80 cents per ton, depending on the particular authority.

(6) While the experiments thus far seem to indicate that the process is, as Bleininger pointed out, a substitute for filter-pressing, it should be noted that it might be more efficient than filter-pressing in the case of very fine-grained or very plastic clays which are filter-pressed with difficulty. It likewise offers a continuous method for the partial dewatering of clays and allied semicolloidal suspensions.

Acknowledgments Grateful acknowledgment is given to Dr. H. F. Yancey, Acting Supervising Engineer of the Northwest Experiment Station, and

to Dean Milnor Roberts of the College of Mines, for assistance and encouragement, and to Professor Hewitt Wilson, Director of Ceramic Engineering, under whose direction the investigation was conducted. Dr. H. V. Tartar, of the Chemistry Department of the University of Washington, criticized the section pertaining to colloidal theory. Rudolph Zane, Research Fellow of the Bureau of Mines, acted as translator of the correspondence in the German language. Sincere thanks are given to the directors of the Carlsbad Electro-Osmose Company, Limited, of Chodau, near Carlsbad, Czechoslovakia, and to Herr Willi Meyer, manager of the company, for the biography of Count Schwerin and for the pictures and description of the plant. S. R. Hind, of Stoke-on-Trent, Staffordshire, England, kindly furnished a copy of his description of this plant and an account of some of his experiments with the electrophoresis process.

BIBLIOGRAPHY

References Pertaining to Colloids and the Colloidal Behavior of Clays

(1) Olof Arrhenius, "Clay as an Ampholyte," *Jour. Amer. Chem. Soc.*, **44**, 521 (1922).

(2) H. E. Ashley, "Technical Control of the Colloid Matter in Clays," *Trans. Amer. Ceram. Soc.*, **12**, 768 (1910). Gives theory of colloid structure.

(3) W. D. Bancroft, "Hypothesis of Cause of Charges," *Trans. Amer. Electrochem. Soc.*, **21**, 233 (1912); also *Jour. Phys. Chem.*, **16**, 312 (1912); **20**, 85 (1916); **21**, 441 (1917).

(4) W. D. Bancroft, Applied Colloidal Chemistry, McGraw-Hill Book Co., New York.

(5) R. H. Bogue, Colloidal Behavior, McGraw-Hill Book Co., New York.

(6) G. A. Bole, "The Mechanism of Plasticity," *Jour. Amer. Ceram. Soc.*, **5**, 469 (1922). Gives theory of structure of charged particle to account for plasticity and the action of electrolytes on clays.

(7) R. Bradfield, "The Chemical Nature of a Colloidal Clay," *Jour. Amer. Soc. of Agronomy*, **17** [5], (May, 1925); Univ. of Missouri Agric. Expt. Sta., *Bull.*, No. 60.

(8) R. Bradfield, "The Relation of Hydrogen Ion Concentration to the Flocculation of a Colloidal Clay," *Jour. Amer. Chem. Soc.*, **45**, 1243 (1923).

(9) R. Bradfield, "The Nature of the Chemical Reactions of Colloidal Clay," Publication of Dept. of Chem., Univ. of Wis., 1923.

(10) R. Bradfield, "The Nature of the Acidity of the Colloidal Clay Solid," *Jour. Amer. Chem. Soc.*, **45** [11], 2669 (1923).

(11) R. Bradfield, "The Importance of Hydrogen Ion Control in Physico-Chemical Studies of Heavy Soils," *Soil Science*, **17** [5], (May, 1924); Reprint, Agric. Expt. Sta., Univ. of Missouri, p. 411.

(12) R. Bradfield, "The Effect of the Concentration of Colloidal Clay upon Its Hydrogen Ion Concentration," *Jour. Phys. Chem.*, **28** [Feb.] 170–75 (1924).

(13) E. F. Burton, The Physical Properties of Colloidal Solutions, Longmans, Green and Co., New York.

(14) E. F. Burton, "First Quantitative Measurement of the Potential between a Colloid Particle and the Surrounding Medium," *Phil. Mag.*, **11**, 425 (1906).

(15) H. J. M. Creighton and C. G. Fink, Electro-Chemistry, Vol. 1, 2d ed. John Wiley & Sons, New York.

(16) D. A. Cruse, "Effect of Temperature on Electrical Endosmose," *Physik. Z.*, **6**, 201 (1905).

(17) A. H. Fessler and H. M. Kraner, "Hydrogen Ion Concentration and the Electrical Conductivity of Clay Slips, Part 1, Plant Study," *Jour. Amer. Ceram. Soc.*, **10**, 501 (1927).

(18) H. Freundlich, Kapillar chemie, p. 245 (1909). Gives hypothesis of the cause of charges on colloidal particles.

(19) René Gallay, "Studies in the Coagulation of Clays," *Kolloidchem. Beihefte*, **21**, 431 (1926).

(20) W. D. Harkins, E. C. H. Davies, and G. L. Clark, "Theory of the Cause of the Charge on Colloids by Orientation of Molecules," *Jour. Amer. Chem. Soc.*, **39**, 541–96 (1917).

(21) Horace Lamb, "The Theory of Electric Endosmose and Other Allied Phenomena," *Phil. Mag.*, **25**, 52 (1888). Discusses the "give" between the so-called "Helmholtz double layer" to produce motion in an electric field.

(22) I. Langmuir, "The Constitution and Fundamental Properties of Solids and Liquids, Part II," *Jour. Amer. Chem. Soc.*, **39**, 1848 (1917).

(23) W. C. McC. Lewis, "Some Applications of Capillary and Electro-Capillary Chemistry," *Jour. Soc. Chem. Ind.*, **35**, 575 (1916).

(24) S. E. Linder and J. Picton, "Early Studies in Electrical Behavior of Colloids," *Jour. Chem. Soc.*, Vols. 61, 67, 71, and 87.

(25) Jas. W. McBain, "Conception and Properties of the Electrical Double Layer," *Jour. Phys. Chem.*, **28**, 706–14 (1924).

(26) Samuel J. McDowell, "The Effect of Various Sodium Silicates and Other Electrolytes on Clay Slips," *Jour. Amer. Ceram. Soc.*, **10**, 225 (1927). Gives theory to explain conclusions; 14 graphs.

(27) S. E. Mattson, "Deflocculation of Clays," *Kolloidchem. Beihefte*, **14**, 227 (1912).

(28) J. W. Mellor, "Plasticity," *Trans. Ceram. Soc.* [Eng.], **21**, 91 (1921–22). Gives theory to explain plasticity.

(29) Leonar Michaelis, "Analogy between Colloidal Particles and Ions," *Kolloid Z.*, **31**, 246 (1922).

(30) Leonar Michaelis, The Effect of Ions on Colloids, Colloid Symposium Monograph, **2**, 1 (1925).

(31) Wolfgang Ostwald, "Properties Dependent on and Independent of the Degrees of Dispersion," *Kolloid Z.*, **33**, 300–306 (1924).

(32) Jean Perrin, "Mécanisme de l'Électriasation de contact et solutions colloidales," *Jour. Chim. Phys.*, **2**, 601 (1904). Effects of ions on electrical endosmose.

(33) R. C. Purdy, "Discussion of Theory of Plasticity," *Trans. Amer. Ceram. Soc.*, **11**, 555 (1909). Believes all phenomena in behavior of clays are due to surface effects.

(34) D. W. Randolph and A. L. Donnenwirth, "Effect of Various Sodium Silicates and Other Electrolytes on Clay Slips," *Jour. Amer. Ceram. Soc.*, **10**, 225 (1927). Gives theory to explain results.

(35) O. C. Ralston, "Electrophoresis and Electro-Osmosis," (two definitions), *Chem. & Met. Eng.*, **27**, 778 (1922).

(36) H. G. Schurecht, "Use of Electrolytes in the Purification of Clays," Bur. Mines, *Tech. Paper*, No. 281 (1922).

(37) Alvin Strickler and J. Howard Mathews, "Studies in Electric Endosmose," *Jour. Amer. Chem. Soc.*, **47**, 1647 (1922). Theory of cause of charge on colloidal particles.

(38) W. A. Taylor and J. K. H. Inglis, "Suggested Theory of the Aluminum Anode," *Phil. Mag.*, **5**, 301 (1903). Effect of a membrane of aluminum hydroxide on hydroxyl ions.

(39) G. Wiegner, "Dispersion and Base Exchange," *Jour. Soc. Chem. Ind.*, **44**, 440–64 (1925). Discusses theory and effects of charge on colloidal particles.

Theories Applying Especially to Electro-Endosmose

(40) Wilder D. Bancroft, "Electrical Endosmose," *Jour. Phys. Chem.*, **16**, 312 (1912). Proposes ionic adsorption hypothesis and applies it to some hitherto unexplained theory of Reed (*Trans. Amer. Electrochem. Soc.*, **2**, 238 (1902)). Article includes addition agents in electroplating.

(41) F. E. Barker and C. D. Hocker, "Relation of Osmose of Solutions of Electrolytes to Membrane Potentials," *Jour. Amer. Chem. Soc.*, **38**, 1029 (1916). Combines ionic adsorption theory of Nernst diffusion theory to account for polarization of membrane.

(42) Albrecht Bethe and T. Toropoff, "Electrolytic Process of Diaphragms I and II," *Z. physik. Chem.*, **88**, 686 (1914); **89**, 637 (1915). Part I discusses the disturbance of neutrality, for example, by added ions; Part II shows that interface potential is an ionic adsorption phenomenon.

(43) T. R. Briggs, "Electrical Endosmose. I," *Jour. Phys. Chem.*, **21**, 198 (1917). Complete historical summary with references to literature, critical study of different theories of electro-endosmose and contact potentials. Author prefers ionic adsorption hypothesis of Bancroft and Freundlich.

(44) T. R. Briggs, Electrical Endosmose Report of British Assn. for Advancement of Science. Colloidal Chemistry, 1918. Discusses theories in order of history of development. Discusses commercial applications of electro-endosmose.

(45) T. R. Briggs, H. S. Bennett, and H. L. Pierson, "Electrical Endosmose. II," *Jour. Phys. Chem.*, **22**, 256 (1918). Authors describe new and convenient electro-osmometer and studies of the relation between the rate of endosmose and voltage, temperature, and other factors. Data tend to confirm the ionic adsorption theory.

(46) T. R. Briggs, H. L. Pierson, and H. S. Bennett, "Electrical Endosmose and Adsorption," *Trans. Amer Electrochem. Soc.*, **31**, 257 (1917).
(47) Horace Byers and Carl H. Walter, "Electrolytic Endosmose, *Jour. Amer. Chem. Soc.*, **36**, 2284 (1914). Complicated endosmotic experiments with three and six compartment cells.
(48) T. R. Briggs, "Electrical Endosmose," *Jour. Phys. Chem.*, **21**, 204 (1917).
(49) Coehn, "Cause of Reversal of Migration of Particles," *Wied. Ann.*, **64**, 64 (1898).
(50) Coehn and Raydt, "Effect of Temperature on Electro-Osmosis," *Drude's Ann.*, **30**, 797 (1909).
(51) G. von Elissafoff, "Effect of Electrolytes on Electrical Endosmose," *Z. physik. Chem.*, **79**, 385 (1912). Important article showing where Perrin's valence holds and where it fails. In an appendix written with Freundlich, the author argues effectually in favor of the ionic adsorption theory.
(52) Foerster, "Practical Uses of Electrical Endosmose," *Elektrochem. Z.*, p. 116 (1915).
(53) Herbert Freundlich, Kapillar chemie, p. 225 (1909). Calculation of value of potential of electrical double layer at solid-liquid interface.
(54) Herman Helmholtz, "Theory of Electrical Double Layer," *Wied. Ann.*, **7**, 337 (1879).
(55) G. Quincke, "Mit lieber die Fortführung materieller Theilchen durch stromende Elektricität," *Pogg. Ann.*, **113**, 113 (1861).
(56) G. H. Wiedemann, *Elektricität*, **1**, 1007 (1893). Discusses Reuss's work in Moscow in 1808.
(57) G. H. Wiedemann, "First Quantitative Study of Electrical Endosmose," *Pogg. Ann.*, **87**, 321 (1852); **99**, 177 (1856).

References on Electrosmosis and Electrophoresis

(58) R. Akizawa, "Technical Applications of the Electrosmosis Process," *Jour. Soc. Chem. Ind.* [Japan], **25**, 1348–66 (1922).
(59) "Electrical Purification of Clays," *Nature*, **103**, 576–77 (1919). Outlines the commercial process of purification by electrical methods.
(60) P. Bary, "Electro-Osmose," *Jour. Chim. Ind.*, **7**, 640–50 (1922); also *Chem. Trade Jour.*, **70**, 625–77 (1922).
(61) A. V. Bleininger, "Use of Sodium Salts in the Purification of Clays and in the Casting Process," U. S. Bur. Stand., *Tech. Paper*, No. 51 (1915). Describes experiments and results with electrophoresis as conducted in the Bureau of Standards laboratory.
(62) Vance S. Cartwright, "Methods of Dewatering Clay Suspensions," Thesis, Univ. of Washington (1928). Gives outline of work preliminary to this paper.
(63) Howard S. Davis, "Electrical Dewatering of Clay Suspensions," Thesis, Univ. of Washington (1929). Outline of further work preliminary to this paper.
(64) J. Duclaux, *Rev. Gen. Colloids*, **2**, 65–72 (1924). A review of electrosmosis and electrophoresis with scientific principles and commercial applications.
(65) J. H. Frydlender, "The Commercial Applications of Electro-Osmosis," *Rev. prod. chim.*, **25**, 721–30 (1922).
(66) A. Granger, "Treatment of Kaolins and Clays by Electro-Osmosis," *Céramique*, **29**, 245 (1926). Principles of process and description of methods employed at Chodau.
(67) L. G. Hall, "Electrical Unwatering of Portland Cement Slurry," *Cement Mill and Quarry* (now *Pit and Quarry*), **32**, Nos. 9, 11, 12, 16 (May, June, Aug., and Dec.) (1928). Theory, experiments in the use of electrophoresis for the dewatering of cement slurry.
(68) S. R. Hind, "A Visit to the Osmosis Plant at Carlsbad," *Trans. Ceram. Soc.* [Eng.], **24**, 73 (1924–25). A detailed description of the plant with specifications, flow sheet, and pictures.
(69) S. R. Hind, "Sedimentation as a Means of Purifying Clay," *Trans. Ceram. Soc.* [Eng.], **23**, 234 (1923–24).
(70) H. Kohl, "Influence of Small Additions of Electrolytes on the Stability of Clay Suspensions and the Use of These in the Purification of Clay," *Ber. deut. keram. Ges.*, **3**, 64–77 (1922). Gives opinion of purification by electrosmosis.
(71) Seiji Kondo, "Experiments on Electrosmosis," *Jour. Chem. Ind.* [Japan], **21**, 385–404 (1918).

(72) W. R. Ormandy, "Electrical Process for the Purification of Clay," *Trans. Ceram. Soc.* [Eng.], **12,** 36 (1912–13).
(73) W. R. Ormandy, Highfield, and Laurie, "History of the Osmose Process," *Min. Jour.*, **23,** 113–16; *Jour. Roy. Soc. Arts*, June, 1925.
(74) W. R. Ormandy, "British Clays under the Osmose Process," *Trans. Ceram. Soc.* [Eng.], **13,** 35 (1913–14).
(75) W. R. Ormandy, "Behavior of Some English Clays under the Osmose Process," *Pottery Gaz.*, **38,** 1162–65. Describes the results of tests with various English clays regarding their color, working qualities, and firing behavior before and after electrical treatment.
(76) W. R. Ormandy, "Practical Application of Electro-Endosmose and Cataphoresis," *Chem. Age* [London], **3,** 475 (1920). Uses of the process in industry.
(77) W. R. Ormandy, "The Osmotic Purification of Clay," *Trans. Ceram. Soc.* [Eng.], **18,** 327 (1918).
(78) W. R. Ormandy, other references: *Brit. Clayworker*, **22,** 9 (1913); *Pottery Gaz.*, **40,** 178 (1915).
(79) Heinrich Paweck, Power in Czechoslovakia, Trans. First World Power Conference, Vol. 4, pp. 597–623 (1925). Discusses the use of electrosmosis in Czechoslovakia.
(80) P. H. Prausnitz, "Technical Electro-Osmosis," *Kolloid-Z.*, **31,** 319–23 (1922).
(81) F. Rowlinson, "Industrial Electro-Osmosis," *Beama*, **8,** pp. 341–45. Discusses the dewatering of peat and of clay by electrophoresis and the Rogers-Bennett process for the extraction of oils.
(82) Count Botho von Schwerin, Patents, see page 261, this issue.
(83) A. B. Searle, "Electricity in the Ceramic Industries," *World Power Conference*, **2,** 226–31 (1924).
(84) Felix Singer, "Gewerke in Deutschland," *Ber. Tech. Wiss. Abt. Ver. Keram.*, **5,** [5], 16–22 (1919). Effects of electro-osmosis on clays.
(85) Felix Singer, Method of Application of Electro-Osmosis to Dewatering of Clays, Die Keramik, pp. 126–29. Friedr. Vieweg und Sohn, Akt. Ges., Charlottenburg, Germany, 1923.
(86) *Trans. Ceram. Soc.* [Eng.], Session 1926–27, Vol. 26, p. xxxiii. Visit to Czechoslovakia and Austria.
(87) Kuno Wolf, "Different Methods of Purification of Clays Including Electrosmosis," *Metall Erg.*, **22,** 474–80 (1925).
(88) P. Bary (Industrial applications), *Chimie et Ind.*, **7,** 640 (1922).
(89) T. R. Briggs, Report of British Assn. for Advancement of Science, 1918. Report on Colloidal Chemistry, pp. 39–52. Reviews critically the different commercial applications of electrosmose and electrophoresis; excellent bibliography.
(90) J. Buse, "Electrical Tanning of Leather," *Jour. Soc. Chem. Ind.*, **19,** 59 (1900).
(91) Review of industrial uses with bibliography, *Chem. Trade Jour.*, **70,** 625 (1922).
(92) H. J. M. Creighton and C. G. Fink, Electro-Chemistry, Vol. I, pp. 167–68, 2d ed., John Wiley and Sons, New York.
(93) John R. Dawkins, "Use of Electrical Endosmose to Lubricate the Die in a Brick Machine," *Clayworker*, **57,** 426 (1912).
(94) H. J. Creighton, "Electrolytic Waterproofing of Textile Fabrics—the Talc Process," *Jour. Frank. Inst.*, **192,** 497 (1925). Describes process in use in Rhode Island for waterproofing textile fabrics.
(95) Kruyt, *Chem. Weekblad*, **14,** 766 (1917).
(96) W. C. McC. Lewis, *Jour. Soc. Chem. Ind.*, **35,** 575 (1916).
(97) W. R. Ormandy, "Practical Applications of Electro-Endosmose and Cataphoresis," *Chem. Age* [London], **3,** 475 (1920).
(98) E. K. Rideal and H. R. Evans, "Some Experiments on the Theory of Electrotanning," *Jour. Soc. Chem. Ind.*, **32,** 633 (1913). Account of experiments in tanning of leather by electro-osmosis.
(99) Williams, *Jour. Amer. Leather Chemists' Assn.*, **8,** 328 (1913).

Miscellaneous References

(100) Robert Back, "Effect of Some Electrolytes on Clays," *Trans. Amer. Ceram. Soc.*, **16,** 515 (1914)
(101) A. V. Bleininger and M. R. Hornung, "Notes on Casting," *Trans. Amer. Ceram. Soc.*, **17,** 330 (1915).

(102) R. J. Clark, "A Laboratory Apparatus for Refining Pacific Northwest Kaolin," *Jour. Amer. Ceram. Soc.*, **10** [2], 98–108 (1927).
(103) Mansfield Clark, Determination of Hydrogen Ion Concentration, 2d ed., Williams & Wilkins, 1922.
(104) G. E. Goodspeed and A. A. Weymouth, "Mineral Constituents of a Certain Kaolin Deposit near Spokane, Washington," *Jour. Amer. Ceram. Soc.*, **11** [9], 687 (1928).
(105) A. B. Searle, The Chemistry and Physics of Clays and Other Ceramic Materials, Ernest Benn & Co., Ltd., 8 Bouverie St., E. C. 4, London, 1924.
(106) Herman A. Seger, Collected Writings, The Chemical Pub. Co., Easton, Pa.
(107) E. W. Scripture, Jr., and Edward Schramm, "Deflocculation of Clay Slips and Related Properties," *Jour. Amer. Ceram. Soc.*, **9**, 175 (1926).
(108) H. B. Weiser, The Colloidal Salts, McGraw-Hill Book Co., 1928.

SCHWERIN'S PATENTS

United States

No.	Date	Description
670,350	March, 1901	Cylindrical apparatus for dewatering peat.
720,186	Feb., 1903	Tray apparatus for dewatering peat.
894,070	July, 1908	Endless belt apparatus for dewatering peat.
972,029	Oct., 1910	Apparatus for generating electric current by forcing suspended material through a diaphragm.
993,888	May, 1911	Addition of electrolytes and charged materials to suspensions to aid in purification by settling.
1,029,579	June, 1912	Addition of colloids of strongly charged character to suspensions to increase effect of electrolyte.
1,121,409	Dec., 1914	Fine grinding of materials as aid to electrosmose.
1,133,967	March, 1915	Electrophoresis machine with drum anode.
1,156,715	Oct., 1915	Electro-osmotic filter press.
1,174,946	March, 1916	Improved agitators, etc., for drum anode machine (Hans Illig named as patentee).
1,229,203	June, 1917	Arrangement of blunger, settling troughs, electrophoresis machines in clay-washing plant.
1,233,713	July, 1917	Elutriation of kaolin by sedimentation with electrolytes.
1,235,063	July, 1917	Separation of colloidal materials in cell containing two diaphragms.
1,266,329	May, 1918	Operation of electro-osmotic filter press.
1,326,106	Dec., 1919	Separation of materials from adsorbing components by electrosmose through suitable diaphragm.
1,326,104	Dec., 1919	Treatment of colloids by electrosmose.
1,326,105	Dec., 1919	Treatment of colloids by electrosmose.
135,221	June, 1918	Elektro-osmose Akt. Gesellschaft. Apparatus for removing liquids so constructed that walls can be moved together as volume of material decreases.
135,815 to 135,820	June, 1918	Same company. Apparatus for removing liquids from substances.

British

12,431	July, 1900	Evidently first British patent; discusses electrical endosmose.
8,086	April, 1901	Extraction of sugar by electrical endosmose.
22,301	Nov., 1901	Apparatus for dewatering peat.
10,793	May, 1909	Production of electric current by Quincke's method.
3,364	Feb., 1911	Acceleration of process by addition of electrolytes (acetic acid, CO_2, etc., and NaOH, NH_4OH).
11,626	May, 1911	Adding of electrolytes, especially Na_2SO_4 to peat.
27,931	Dec., 1911	Addition of adsorbed colloids to expedite process.
28,185	Dec., 1911	(Gesellschaft für Elektro-osmose, Frankfurt-am-Main.) Out line of settling and osmose process for clays.
725	Jan., 1912	(Gesellschaft für Elektro-osmose.) Osmose machine with rotation anode.
14,235	June, 1912	Use of electro-osmose in connection with manufacture of refractory articles, baked without binder.

14,369	June, 1912	Schwerin-Electro-osmose filter press.
23,545	Oct., 1912	(Gesellschaft für Elektro-osmose.) Electro-osmotic filter press.
24,666	Oct., 1912	Schwerin—Use of electrically-charged diaphragms in the fractional separation of suspended colloids.
29,826	Dec., 1912	Gesellschaft für Elektro-osmose and H. Illig. Improved apparatus for dewatering clay.
3,434	Feb., 1913	Gesellschaft für Elektro-osmose. Making ceramic articles without adding flux.
10,873	May, 1913	Gesellschaft für Elektro-osmose. Electro-osmotic filter-press improvements.
26,061	July, 1913	Gesellschaft für Elektro-osmose. Further improvements in osmose machine.
6,993	March, 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Facilities for dewatering of peat by previous grinding in ball mill.
6,995	March, 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Adds adsorbed colloid before grinding.
9,237	April, 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Preparation and purification of colloidal silicic acid.
9,261	April, 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Making stable metal sols by adding colloidal silicic acid.
11,823	May, 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Separation of colloids by electro-endosmose.
19,849	Sept., 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Tanning and dyeing by electro-osmose.
21,189	Oct., 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Changes interface potential of diaphragms by additional agents.
21,190	Oct., 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Modification of tanning process.
21,448	Oct., 1914	Elektro-osmose Akt. Gesellschaft (Schwerin). Combined electrical dialysis and ultra-filtration process.
21,483	Oct., 1914	Gesellschaft für Elektro-osmose. Improvement on tanning process.
6,727	May, 1915	Elektro-osmose Akt. Gesellschaft (Schwerin). Electrical purification of alums.
7,212	May, 1915	Elektro-osmose Akt. Gesellschaft (Schwerin). Electrical purification of alumina.
9,565 } 9,566 }	May, 1915	Elektro-osmose Akt. Gesellschaft (Schwerin). Electrical purification of dyes.
11,659	Aug., 1915	Elektro-osmose Akt. Gesellschaft (Schwerin). Treatment of clay.

APPENDIX

Other Applications of the Electrokinetic Process

Besides the use of the process in the dewatering of clay and peat, as previously described, the following applications have been proposed or are being used in industrial processes (references 88, 91, 92, 95, 96, p. 260):

(1) Lubrication of the die in brick machines (reference 93, p. 260).
The die is made the cathode and the water which collects because of the action of electrophoresis acts as lubricant.
(2) Dehydration of coloring matters.
(3) Dehydration of finely-divided stearate.
(4) Purification of glues, gelatine, crude glycerol, fruit juices, nitrocellulose, alkaloids, and serums.
(5) Extraction of sugar from beets and molasses.
(6) Preparation of silica gels from sodium silicate.
(7) Separation of oil-water emulsions in the petroleum industry.
(8) Fractionation of suspended colloids.
(9) The decolorization of liquids.
(10) Concentration of radio-active substances.
(11) Plating of rubber.

(12) Infiltration of drugs.
(13) Purification of tan liquors.
(14) Tanning. See References 89, 90, 97 to 99, p. 260.
(15) Sterilization and improving of food stuffs.
(16) Preservation of green fodder.
(17) Preparation of aluminum hydroxide.
(18) Water-proofing of textile fabrics (reference 94, p. 260).
Process in commercial use, Cranston, Rhode Island. Aluminum stearate deposited in pores of cloth.
(19) Preparation of gelatin for photographic emulsions.

WORK OF COUNT SCHWERIN

Wishing to secure direct information concerning Count Schwerin and the Carlsbad osmosis plant, the author wrote to Herr Willi Meyer, manager of the plant. He responded generously with the desired information and sent a flow sheet of the plant (Fig. 5) and photographs (Figs. 1 to 4, inclusive). The following quotations are taken from Herr Meyer's letter.

Biography of Count Dr. Botho von Schwerin

Count Botho von Schwerin was born in Wildenhoff, East Prussia, the second son of Count von Schwerin. He attended the gymnasium at Koenigsburg and, after graduating, studied law and philosophy in the Universities of Bonn, Berlin, and Munich. In 1893 he received the degree of Doctor of Jurisprudence and took his leave as "referendar." He then studied chemistry, following his special calling first under Professor Emil Fischer (famous protein chemist) at the University of Berlin and later under Professor Bayer (inventor of the indigo synthesis) in Munich. After completing the prescribed courses, he began, with the assistance of Professor Piloty in the University of Munich, his scientific work in the dehydration of peat. This problem interested him especially because he was born in East Prussia. Although at that time the so-called "science of colloid chemistry" had just begun and its use in industry was unthought of, the far-sighted inventor realized that certain laws of colloid chemistry (especially the laws of electro-osmosis, which at that time had been already discovered) were usable for the industrial dehydration of raw peat, which is a partially colloidal material. Accordingly, an experimental plant was erected in Wildenhoff. In the winter of 1901 and 1902 the inventor gave a lecture concerning his scientific and technical work before Kaiser Wilhelm II. Due to the excellence of this presentation he was made a member of the Order of the Red Eagle.

During the years 1902–1909 he worked on the technical perfection of his discoveries in the field of electro-osmosis, confining himself principally to the dehydration of peat. Soon, however, he realized the possibilities of using the same laws for the purification and dehydration of other colloidal materials occurring in the natural state, especially clay and kaolin. Through the Hoechst Color Works (which now belongs to the I. G. Dye Industry) in Hoechst-am-Main, a laboratory was put at his disposal. His scientific co-worker was Herr Mueller von Bernick.

From 1909 he continued his experiments in Frankfort-am-Main with Felton, Guilleaume, and Lahmeyer. After the sale of this concern to the United Electric Company of Berlin, Count Schwerin, with a few friends from the German Grossindustry, founded, in 1911 in Frankfort-am-Main, the Electro-Osmose Company, Limited, for the practical application of his discoveries. This company was later changed into a corporation and its headquarters transferred from Frankfort to Berlin in 1913. Count Schwerin was technical advisor of the corporation.

In 1911 this company began the practical use of his process. With a large staff of assistants, Count Schwerin continued his investigations in electro-osmosis. His premature death occurred in the midst of his most intensive labor (February 15, 1917). It is to be regretted that he could not live to see the practical application of his discoveries.

The scientific discoveries of Count Schwerin in the purification of clay and kaolin by electro-osmosis were covered by patents. A large number of these were taken out in all of the civilized countries of the world. In America these patents were seized by the American government during the war and all efforts of the Electro-Osmose Company to recover them after the war were futile."

CENTURY OF PROGRESS

IN CERAMICS

Chicago, Illinois **1933**

For discussions and plans of committees for the Ceramic Exposition at the World's Fair in Chicago see forth-coming issues of the **Bulletin of the American Ceramic Society.**

CERAMIC ABSTRACTS

Compiled by the

AMERICAN CERAMIC SOCIETY

Ross C. Purdy, Editor

Abstractors: H. W. Alexander, A. Ally, A. A. Ayars, R. Barta, L. T. Brownmiller, E. C. Clemens, M. A. Ewer, C. G. Harman, R. A. Heindl, E. B. Hewitt, H. Insley, S. Kondo, M. V. Kondoidy, W. Lerch, G. H. McIntyre, W. W. Meyer, R. G. Mills, A. J. Monack, E. P. Rexford, I. Rhode, D. E. Sharp, G. R. Shelton, H. H. Stephenson, J. N. Ulman, Jr., E. J. Vachuska, A. E. R. Westman, W. C. O. White.

Vol. 10 **March, 1931** **No. 3**

Author Index to Ceramic Abstracts for March[1]

van Ackeren, J. 218, 219
Aladdin Industries, Ltd. 187
Alexander, C. 169
Alimarin, I. P. 224
Alison, A. 215
Anderson, J. E. 201
Anderson, T. B. 166
Anorae 169
Andreasen, A. H. M., and Lundberg, J. J. V. 207
Auerbach, E. 209

Baire, G. 171
Beck, R. D. 177
Becker, J. 219
Benfey, G. 191
Bernauer, F. 165
Berry, A. J., and Durrant, P. J. 223
Berthelot, C., and Orcel, J. 230
Bessey, G. E. 172
Binns, C. W., and Booth, C. 164
Black, G. E. 218
Blair, G. W. S. 224
Blank, A. J. 170, 171
Blythe, N. C. 178
Bodin, V., and Gaillard, P. 229
Boehm, G., and Steiner, D. 209
Bognar, E. J. 199
Bolton, B. B. 170
Bonini, C. F. 230
Booth, C. 164
Bork, A. X. 181
Bössner, F. 216
Botvinkin, O. K. 179
Boulton, W. H. 170
Bowles, O. 208
Boyles, C. H. 213
Bragg, W. 225
Brancart, A. 186
Brancart, Y. 187
Brill, R. 172
British Thomson-Houston Co., Ltd. 187
Brummitt, W. 166
Bucherer, H. T., and Meier, F. W. 222
Buckingham, J. 230
Buckley, F. 167
Budnikoff, P. P., Gicharevitsch, S., and Schachnovitsch, I. G. 194
Budnikoff, P. P., and Hisch, B. A. 198
Buerger, M. J., and Harrington, V. F. 207
Burt, F. McC. 175, 176
Burton, E. F., and Annetts, M. 225
Byrnes, C. P. 184

Calvert, R. 222
Carborundum Co., Ltd. 165
Carrington, H. 230
Cases, M. 201
Chesters, J. H., and Rees, W. J. 199
Christie, L. M. 192
Cincinnati Grinders, Inc. 165
Ciyle, J. C. 234
Clark, F. S. 233
Clark, J. Jr., Electric Co. 163
Clark, W. M. 229
Clark Tructractor Co. 211
Clute, E. 191
Cochran, R. S. 182
Cohn, W. M. 199, 202
Cole, L. H. 173
Cotton, H. E. 191
Cox, G. C., and McIntyre, H. K. 184
Cross, B. J. 232
Cutler-Hammer, Inc. 210

Daum, H. 200
Davies, C., Jr. 218
Davis, F. 168, 169
Davis, J. D. 207
Dehn, F. B. 187
Delaby, R. 221
Deutsch-Englische Quarzschmelze Ges. 186
Dews, H. C. 177
Dickey, F. 191
Doermann, A. J. 164
Doerner, H. A. 199
Dornedden, C. 211
Dougherty, W. E. 178
Duckenfield, P. W. 199
Dunbar, C., and Machatschki, F. 220
Du Pont Viscoloid Co. 187
Durnin, J. V. 212

Eardley-Wilmot, V. L. 164
Eckdahl, W. P. 224
Editorial 234
Ellis-Anwyl, R. H. 190
Emerson, J. 185
Emery, W. 214
Ettore, C. 202

Favre, P. A. 186
Fieldner, A. C., Selvig, W. A., and Frederic, W. H. 217
Flynn, A. E. 172
Fontana, C. G. 173
Francis, J. L. 176
Frisby, B. 236
Fuerst, E. W. 170

[1] The abbreviation (*C. A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

The bold-face number following the journal name is the volume, the issue number is in brackets, followed by the page numbers, then the year in parentheses.

Galusha, A. L. 220
Gander, J. S. 233
Geerling, G. K. 192
Gerbel, M., and Reuntlinger, E. 235
Gleason, C. R. 211
Goldman, G. M. 205
Gooskov, W. A. 217
Grange, L. I. 220
Green, A. T. 197
Green, A. W. F. 211
Greenawalt, J. E. 212
Griggs, J. O. 200
Guerin, J. 172
Günther, E. 215
Günther, H. 222
Gustafsson, J. R. 165
Guttmann, A., and Gille, F. 171, 172

Hackett, R. W., and Worrall, A. G. 184
Hanley, J. A., and Pinner, W. L. 212
Hansen, H. 198
Harbeson, J. F. 166
Harding, K. 189
Heaton, M. C. 184
Hein, L. 204
Heisey, T. C. 170
Heizei, W. 166
Heyroth, A. H. 212
Hillmann, H. 184
Hind, S. R. 214
Hirsch, H. 198
Hirshfeld, C. F., and Moran, G. U. 230
Holmes, H. N., and Elder, A. L. 222
Hottinger, A. F. 203
Hough, A., and Harrison, J. G. 192
Houston, R. A. 166
Hoxie, E. A. 207
Hutchinson, A. 201

Ilsley, L. C. 211
Igei, M. 235

Johnson, J. V. 192
Jones, F. D. 211
Jones, S. M. 204
Justice, J. 170

Karrer, E. 224
Kameyama, N., and Oka, S. 227
Kelch, N. W. 190
Kelso, H. F. 205
Kethel, R. J. B. 198
Kieffer, E. 198
King, W. 168
Kingsley, C. B. 183
Kinzie, C. J. 178
Kitaigorodsky, I. I., and Schkolnikoff, I. A. 180
Kober, H. 209
Köhler, E. 194
Koenig, E. W. 180
Koidl, T., and Gorlich, F. 194
Koyanagi, K. 171
Krauss, F., and Jörns, G. 172
Kremski, H. 199
Kurlander, R. V. 167

Laffineur, E., and Collin, L. 187
La Forge, G. S. 173
Lastovicka, V. 220
Laubenheimer, A. 221
Lauff, H. 177
Layer, F. C. 192
Lee, F. W. 222
Leiss, C. 207
Lent, L. B. 190, 191
Lessing, R. 217
Levy, A. H. 209
Lewis, C. E. 212
Liberty Glass Co. 236
Lichtenberger, T., and Kaiser, L. 219
Liesegang, W. 214
Link-Belt Co. 210
Locreille, C. 186
Loebell, H. O. 218
Lynch, J. W., and Bridges, E. G. 185

MacIntire, W. H., Shaw, W. M., and Young, J. B. 220
Mackin, J. F. 212
Madel, H. 207
Magoffin, R. V. D., and Davis, E. C. 170
Mansur, H. H. 215
Marbaker, E. E. 227
Marks, L. S. 236
Martin, G. 173
Martin, J. D. 211
Masin, J. S., and White, H. E. 164
Mason, C. W. 226
Matějka, J., and Nikitin, A. 231
Maurach, H. 235
Maus, K. 194
McAnally, S. G. 172
McBain, J. W., and Kistler, S. S. 223
McBride, J. A. 170
McCaffery, R. S. 227
McIntyre, W. A. 188
Meier, F. W. 227
Metalliges. Akt.-Ges. 201
Miehr, W., Kratzert, J., and Koch, P. 198
Miller, O. C. 184
Milne-Watson, D. 215
Moler Products, Ltd. 200
Monarch Machine Tool Co. 211
Moncrieff, Ltd., J., and McNish, A. F. 187
Mooney, M. 226
Moore, H. 210
Morgan, J. R. 182
Morris, J. 229
Morse, C. T., and Hogan, E. L. 211
Mowrey, F. W. 181
Mylius, W. 226

Nasini, R. 229
Nawrath, A. 213
Nealey, J. B. 204
Niebuhr, D. 235
Nutting, P. G. 224

O'Rourke, J. F. 192

Palmer, R. L. 203
Parmelee, C. W., and Harman, C. G. 225
Pass, R. H. 216
Payne, J. M., Jr. 170
Peiler, K. E. 183
Pelka, O. 170
Permiakov, V. M. 203
Pesserl, F. R. 181
Petar, A. V. 220
Phelps, S. M., and Booze, M. C. 201
Philippi, T. F. 164
Pigott, R. J. S. 233
Pilkington Bros., Ltd., Waldron, F. B., and Griffin, J. H. 186
Pillatzke, J. M. 219
Pintsch A.-G., J. 219
Pistor, G. E. J. 202
Platzmann, C. R. 173
Pollatschek, H. 226
Powell, A. R., and Schoeller, W. R. 223
Powers, E. S. 189
Proctor, J. A., and Bailey, W. M. 205
Puri, A. N. 206

Rackham, B. 168
Reimers, A. 195
Richardson, L. 169
Richter, G. M. A. 169
Riddell, G. C., and Liddell, D. M. 181
Riddell, W. C. 172
Rieke, R., and Navratiel, H. 203
Robitschek, J. 198
Roehm, V. J. 204
Rogers, J. F. 218, 219
Romig, J. W. 215, 216
Rowe, E. H. 210
Rowley, C. A. 183
Rowley, C. A., and Reece, J. A. 183
Royen, H. J., and Grewe, H. 223
Ryschkevitsch, E. 198

Sakier, G. 170
Sayers, F. 192
Schaal, R. B., and Fuller, D. H. 176
Schaub, E. J. 170
Schirm, E. 173
Schmidt, M. 170
Schulz, E. H., Hartmann, F., and Kanz, A. 199
Schydlo, A. 166
Searle, A. B. 190
Senex. 216
Shaw, M. B., Bicking, G., and O'Leary M. J. 232
Shead, A. C., and Heinrich, B. J. 228
Sheean, J. L. 168
Sherman, A. G., and Meadows, A. 178
Sherts, J. H. 183
Shetrone, H. C. 170
Shilin, A. I. 180
Siegens, H. 200
Silica Products Co. 220
Simonis, I. 183
Sloan, T. H. 183
Smith, A. 175
Smithells, C. J. 178
Société des Forges et Acieries de Commercy. 219
Solodovnikova, L. 228
Sommer, F. 197
Spencer, G. L., Jr. 199
Stanworth, J. 221
Steele, C. J. 170
Steffens, W. 222
Steger, W. 206
Stevens, H. D. 164
Stiasny, E. 232
Storey, W. R. 167
Straub, F. G. 233
Stuart, C. 167
Sugden, J. A., and Cobb, J. W. 199
Suzuki, T., Tanaka, H., and Kurita T. 200
Swain, P. W. 234
Swain, R. E. 185
Swallow, S. C. H. 195

Tammann, G., and Bandel, G. 179
Tams, J. E. 205
Tananaeff, N. A., and Babko, A. K. 222
Tcherepoff, O. V. 203
Terres, E., and Kronacher, H. 217,
Thomas, A. W., and Whitehead, T. H. 225
Thorpe, W. A. 167
Threlfall, C. R. F. 199
Tomita, U. 170
Tridenti, C. 168
Triggs, W. W. 165
Turner, W. W. 203

Uehling Instrument Co. 210

Van der Kragt, W. J. 193
Vass, P. 235
Vassits, M. M. 169
Vielhaber. 173, 175
Von Oppenheim, M. 169

Wade & Son, Ltd., G., and Wade, G. A. 205
Walker, P. H., and Kenyon, S. S. 200
Waters, J. P. 209
Watts, A. S. 205
Weaver, H. F. 170
Weiser, H. B. 225
Wells, W. E. 210
Wenham, E. 167
Wensel, H. T., and Roeser, W. F. 228
West, F. 198, 209
Whitaker, J. W. 229
Widemann, R. V., Jourdain, A., and Cassan, H. 236
Wilcox, A. C. 185
Williams Patent Crusher and Pulverizer Co. 209
Williams-Thomas, H. S. 182
Williamson, J. 213
Williamson, R. V. 225
Winkelmann, H. 197
Wohlenberg, W. J. 233
Wolf, J. 222
Wolff, C. H. 178
Wright, H. G. 208
Wurtz, F. 202

Zabelli, A. 221
Zegshda, V. 198
Zemiatschensky, P. A. and Zenkowitsch, F. A. 195
Zoubtschaninov, V. P., and Smirnov, D. I. 228
Zschacke, F. H. 182
Zwermann, C. H. 170
Zwetsch, A., and Buecking, W. 195

Abrasives

Polishing wheel truing machine. ANON. *Brass World*, **26** [10], 275 (1930).—A new type of automatic polishing wheel truing machine is offered by the Excelsior Tool and Machine Co. The machine will true felt, leather, fabric, or buff wheels to any shape by means of straight or master-shaped abrasive cutting wheels. There is no tendency to burn or injure the wheels. The standard size machine will take wheels up to 16-in. diameter and up to 6-in. face. The polishing wheel is oscillated as it is trued in order to provide better surfacing action and preserve the grinder. E.P.R.

Portable hand grinder. ANON. *Brass World*, **26** [10], 264 (1930).—A new series of portable, heavy-duty hand grinders has been developed and placed on the market by the Hisey-Wolf Machine Co. The machines are 1 and 2 h.p. capacity, equipped with ball-bearing motors and roller-bearing spindles. Motors are rated for continuous duty and mechanical parts have been designed for severe service. These machines are available for either d.-c. or a.-c. operation. E.P.R.

Machine for cutting brick. JAS. CLARK, JR., ELECTRIC CO. *Brick Clay Rec.*, **77** [13], 738–39 (1930).—A heavy-duty machine on which a 12-in. wheel can be raised or lowered $4^1/_2$ in. with the vertical feed arrangement and a second machine for cutting slabs $13^1/_2$ in. from the center of the slab are described. E.J.V.

Abrasives. V. L. EARDLEY-WILMOT. *Mineral Ind.*, **38**, 1–13 (1929); for abstract see *Ceram. Abs.*, **9** [12], 1003 (1930). (*C.A.*)

PATENTS

Making abrasive disks. ALBERT J. DOERMANN. U. S. 1,785,437, Dec. 16, 1930. The process of making an abrasive disk comprising mixing powdered abrasive and bakelite cement, placing the same in a mold with a layer of finely-powdered abrasive on the bottom, and baking.

Producing high-purity abrasive materials. JACOB S. MASIN AND HAROLD E. WHITE. U.S. 1,786,016, Dec. 23, 1930. (1) A process for the direct production of high-purity crystals of aluminous oxide from bauxite, which consists in smelting the bauxite in the presence of sufficient carbon to produce an acid-decomposable matrix in which the crystals of high-purity crystalline aluminous oxide are formed, dissolving the matrix in a bath containing dilute sulphuric acid, and separating the crystals therefrom. (2) A process for the production of a high-purity abrasive material, which consists in furnacing a charge of bauxite with an excess of carbon to reduce substantially all the oxides of silicon, iron, titanium, and a small percentage of alumina present in the bauxite, then cooling the fused mass and forming a high-purity crystalline alumina embedded in a matrix of acid-decomposable character, the character being the result of the excess of the carbon in the charge, then crushing and separating undesirable portions of the fused mass, and subjecting the crushed material to the dissolving action of a bath of dilute sulphuric and hydrofluoric acids.

Grinding machine. CLEMENT BOOTH. U. S. 1,787,337, Dec. 30, 1930. In a grinding machine, the combination with a pair of opposed grinding and regulating wheels forming a grinding throat between them, of a block within the grinding throat, a work-rest blade secured to the block, a bracket carried by the block, a lever pivotally secured to the bracket, resilient means for urging one end of the lever toward the work-rest blade, and positive means for retracting the end of the lever from the work-rest blade.

Grinding or buffing machine. HORACE D. STEVENS. U. S. 1,787,412, Dec. 30, 1930. A grinding or buffing machine comprising a conveyer wheel, studs carried by the conveyer wheel and adapted to have freely journaled thereon objects to be ground or buffed, a traveling abrasive element, means for intermittently rotating the conveyer wheel to bring each object successively into engagement with the abrasive element, and means for rotating the objects on the studs in a direction counter to the direction of the abrasive element.

Roll-end grinder. GEORGE W. BINNS AND CLEMENT BOOTH. U. S. 1,788,046, Jan. 6, 1931. A grinding machine including a pair of opposed rotatable disks having their peripheries contoured to correspond with the work piece being operated upon, means for rotating the disks in a common direction about their axes at the same peripheral speed, means for supporting a work piece intermediate the disks for lateral engagement and rotation by the disks, the contoured portion of the disks limiting the axial movement of the work piece and a grinding member supported adjacent the work-engaging means for operation on the work while rotated by the disks.

Grinding and polishing machine. THEODORE F. PHILIPPI. U. S. 1,788,249, Jan. 6, 1931. In a grinding and polishing machine, the combination of a stationary support, a plurality of vertically-disposed tubular bearings carried by the support, a pair of uprights slidably mounted in the bearings, a frame fixed to the uprights, means coöperating with the frame and the support for counterbalancing and yieldingly supporting the uprights and the frame and parts carried thereby, a horizontally-disposed shaft revolubly carried by one of the uprights and the frame, a work-engaging wheel fixed to the forward end of the shaft, a work support disposed below the wheel for presenting

the work into engagement therewith, a horizontally- and laterally-disposed extension fixed to one of the uprights, and adjustable means coöperating with the extension and the support for yieldingly urging the uprights and frame and parts carried thereby in one direction relative to the support and limiting the movement of the uprights and parts carried thereby in the opposite direction, the means being adjustable to vary the yielding pressure.

Grinding wheels. CARBORUNDUM CO., LTD. Brit. 336,631, Dec. 10, 1930. In a grinding wheel built up of segmental abrasive blocks mounted on a metal drum and held in position by dovetailed ribs, expansion joints are provided between the segments and between the segments and the drum to allow for changes of temperature of the wheel. The joint between the drum and the segments consists of paper laid on the drum, over which is then applied a layer of cement, *e.g.*, a cement consisting of 95% sulphur and 5% ground coke, and the joints between the segments consist of a layer of paper, preferably corrugated, embedded in cement of the same composition; the cement is poured in while molten, the wheel being assembled in a clamp and heated prior to pouring in the cement. The paper is from $^1/_{32}$ in. to $^1/_{16}$ in. thick; in place of the paper, press board, fiber board, wood veneer, or an elastic cement may be employed. See also Brit. 319,200 (*Ceram. Abs.*, **9** [1], 11 (1930)).

Grinding or abrading. W. W. TRIGGS. Brit. 337,003, Dec. 17, 1930. A grinding machine comprises grinding wheels mounted on a spindle capable of continuous axial reciprocation during grinding or of axial movement to a predetermined position in which it is held during grinding, means being also provided for the automatic withdrawal of the grinding wheels at the completion of the operation.

Grinding crank pins, wheel journals, etc. J. R. GUSTAFSSON. Brit. 337,189, Dec. 17, 1930. (1) Apparatus for grinding crank pins on locomotive wheels and journals on wheels for railway cars consists of a spindle having a flanged end which is clamped against the end of the crank pin by braces and bolts and is held in axial alignment with the crank pin by a pin located within the spindle, and pressed so that its pointed end engages the center mark of the crank pin by a screw adjustable in the brace. (2) For grinding crank pins with a lateral projection adapted to carry an eccentric, a yoke member is provided carrying the grinding wheel which is driven by belt gearing from the motor.

Grinding rollers, balls, etc. CINCINNATI GRINDERS, INC. Brit. 337,451, Dec. 24, 1930. A centerless grinding machine for grinding balls, tapered rollers, etc., has contoured or grooved grinding and regulating wheels, and the balls, etc., are moved from one groove to another so that the grinding is performed in steps.

Art and Archaeology

Crystallographic observations on some crystal glazes. F. BERNAUER. *Ber. deut. keram. Ges.*, **11** [3], 97 (1930).—The medium in which the crystals are developed in glazes is similar to many organic materials in influence of viscosity, polymerization of the molecule, and complex chemical composition. B. has considered (1) single crystals, (2) crystal aggregates, (3) sphaerolites, (4) drilled crystals, (5) effects of film on the surface, and (6) construction or tension of the surface. Besides the chemical properties of the melt and the inner physical condition, the surface tension will influence the formation of crystals in very thin glaze layers. I.R.

Colors in glass. ANON. *Ceram. Ind.*, **16** [1], 41–42 (1931).—The theory of colored glass is given. In general, the color of a glass may be ascribed to (1) a substance which inherently possesses the property of absorbing all but certain wave lengths of light, (2) the formation of colloids which permeate through the glass, and (3) the formation of an

emulsion on the glass. The coloring effects of iron, manganese, cobalt, chrome compounds, and copper are discussed and several colored-glass batches given together with treatments necessary to give certain colors. The method of producing colors due to colloids in glass is also discussed and the making of ruby glass by this method is described, as is the use of sulphur in the manufacture of amber glasses. Batches for glasses of the above kinds are given. W.W.M.

New ideas about color vision. R. A. HOUSTON. *Sci. Progress*, **25**, 270–81 (1930).—Graphs connecting brightness with sensation are given. The curves resemble those of the Gaussian theory of errors. H.H.S.

Research in tableware design at Ohio State University. THOMAS B. ANDERSON. *Pottery Glass & Brass Salesman*, **42** [19], 9 (1930).—Among the outstanding shapes developed during 1930 are the "Nouvelle" and "Primrose" dinner services of the American Chinaware Corp. The "Nouvelle" is in buff-colored body; the "Primrose" in ivory. A two-tone ware by the Steubenville Pottery Co. is also mentioned and is a delicate pink body with a pure white embossed band at the edge of the ware, all covered with a brilliant glaze. The Salem China Co. is producing a line of underglazed prints in all-over patterns on a shape closely resembling the "Spode Gadroon Edge." A. discusses what may be expected in advancement in 1931. The article was given as an address before the Art and Design Committee at the U. S. Potters Assn. annual convention. E.P.R.

Ceramic models from nature. W. HEIZER. *Schaulade*, **6** [15], 1042–44 (1930).—Expressionism in ceramic reproductions of animal figures with regard to the quality of the material, whether china, earthenware, or faience, and with regard to the realistic qualities of the figures is illustrated by modern German ceramic models. M.V.K.

Artist as potter. ARTHUR SCHYDLO. *Sprechsaal*, **63** [51], 970–71 (1930).—S. suggests that in technical ceramic schools the pupils should have a solid basic knowledge of all ceramic industries before specializing in any one line. The schools should develop individuality and originality in the work of the pupils. M.V.K.

Decorating concrete floors. WYATT BRUMMITT. *Pencil Points*, **11** [11], 879–82 (1930).—The advantages of and methods for decorating concrete floors are described. A table indicating approved means of obtaining various colors is included. Illustrated. E.B.H.

Design in modern architecture. Stained glass and mosaic. JOHN F. HARBESON. *Pencil Points*, **11** [12], 957–63 (1930).—Much of the leaded glass of recent years looks out of place in this day of machine-made glass. Even those in the modern school where none but functional lines are tolerated are apt to complicate leaded glass patterns, but they are responsible for an interesting development. Believing that modern art should be a product of modern conditions, architects are using with great skill the "obscure" glass of commerce. Not interested in realism, more attention is paid to composition and technique. In mosaics they have accepted the technique of the Byzantine work, not hard and even, but affording play of light on the surfaces. In both mosaics and leaded glass, execution is important for mechanical execution will spoil even good design. No good work has yet been done that makes use of methods of quantity production except the manufacture of raw materials. The technique is still that of history. Illustrated. E.B.H.

New pottery and glassware. ANON. *Pottery Glass & Brass Salesman*, **42** [20], 101 (1930).—Full descriptions are given of pottery and glassware exhibited by the following companies: (1) Copeland & Thompson, Inc., (2) Rosenthal China Corp., (3) Langfelder, Homma & Hayward, Inc., (4) Paul A. Straub & Co., (5) Taylor, Smith, & Taylor Co., (6) Lazarus & Rosenfeld, (7) Theodore Haviland & Co., and (8) Brush Pottery Co. *Ibid.*, **42** [21], 12 (1930).—(1) Lancaster Glass Co., (2) Fulper Pottery Co.,

(3) Wm. G. Mueller Co., (4) Frank L. Van Deman & Son, (5) Haruta & Co., and (6) Duncan & Miller Glass Co. E.P.R.

American glassware. WALTER RENDELL STOREY. *Nat. Glass Budget*, **46** [35], 18–19 (1930).—An exhibition of early American glass is being held at the Art Center in New York. Glassware from Stiegel's Works and the Wistar's work plant are discussed and contrasted. The Stiegel glassware is made of clear or colored flint glass of fine quality and the decorations in etched ornamentations or in enameled colors follow European styles. E.P.R.

Making stained-glass windows. REGINE V. KURLANDER. *Nat. Glass Budget*, **46** [36], 16 (1931).—History states that colored or stained glass comes from the east and that no less than 5000 or 10,000 years ago the Egyptians made jewels out of pot metal. Stained glass is one of the earliest arts, and authentic sources state that the earliest stained-glass windows, or rather those approximating stained glass, were found in basilicas of Christian Rome, the arched window openings being filled with marble slabs in which were piercings to receive the colored glass. The glass of the early Christians, authorities say, must have been simple mosaic in stained glass, unpainted. As early as 979 A.D. Venetian glassworkers settled at Limoges. This probably accounts for some of the earliest French glass which is to be found at Chartres, Le Mans, Angers, Rheims, and Chalons-sur-Marne. There are eighteen processes required for making the smallest piece from stained glass. These are making the small colored design, the figure studies, making the full-sized black and white cartoons, selecting the glass, making the outline drawing, cutting the glass, painting the outlines, the first firing, setting out the colored pieces of glass for the painter, the first shading with mat or stipple, the second firing, the second shading process, the third firing, corrections and yellow stain, the fourth firing, glazing, cementing, and binding. All color in glass is molten metal. At Chartres pure gold was used in the making of much of the glass. Flashed glass (a piece of glass with another color flashed on) is also used, as in the case of ruby-colored glass. The ruby color penetrates one part of the glass and is therefore coated on one side only. E.P.R.

Colorful value of English lusterware. CHARLES STUART. *Arts & Dec.*, p. 41 (Jan., 1931).—This pottery, an English revival of the early Spanish and Italian art, was fashionable for a short time during the last century and has of late again become popular. The article is illustrated with examples of both the early English and modern types. G.R.S.

Silver beakers and goblets. EDWARD WENHAM. *Arts & Dec.*, **34** [2], 46 (1930).—The evolution of modern glassware from ancient drinking vessels is traced. Illustrated. E.B.H.

Beginnings of English cut glass. W. A. THORPE. *Connoisseur*, **86**, 226–34 (1930).—Bohemian and Bavarian cut glass were being sold by auction in England in 1709. The English imported workmen and started making it themselves about five years later. Illustrated. H.H.S.

Fine old English glasses. V. Jugs. VI. Jelly glasses. FRANCIS BUCKLEY. *Glass*, **7** [8], 318–20 (1930); **VII. Candlesticks.** *Ibid.*, **7** [9], 356–58 (1930); **VIII. Decanters.** *Ibid.*, **7** [10], 396–98 (1930); **IX. Tankards.** *Ibid.*, **7** [11], 450–52 (1930); for Part IV see *Ceram. Abs.*, **9** [11], 907 (1930). H.W.A.

French and Belgian glass exhibits. ANON. *Nat. Glass Budget*, **46** [37], 17 (1931).—Glass and crystal novelties created by noted designers are being exhibited at the Galeries Bernheim Jeune. Madame Vandel specializes in mosaics of a highly-decorative effect. Maurice Marinot is exhibiting at the Galerie Hebrard crystal flasks lined with pink motifs or black glass veined with red or blue; also, a flask with artificial snow flakes inside between two layers of crystal. The Swedish decorative industry has now a gallery

with a special section for art glass and ceramics. Another French artist, Malabert, has created a novelty lamp with crystal legs and prismatic refractions. E.P.R.

History of Chinese pottery. J. LYMAN SHEBAN. *Ceram. Ind.*, **16** [1], 54–65 (1931).—The origin of the potter's wheel is claimed by the Chinese. There is no proof, but Hobson says the wheel belongs to Egypt, the Mediterranean, and Western Civilization and China with her dependencies. A Chinese philosopher who died in 122 B.C. mentioned the potter's wheel in his writings. The introduction of the wheel changed pottery from an occupation of the women to an occupation for men. Earliest records show that the Chinese used two ingredients in their ware: kaolin and petuntse, a feldspathic rock, the former constituting the porous body and the latter the transparent glaze. The Chinese used a variety of other materials to some extent, including powdered quartz and clays less pure than kaolin. Present Chinese pottery consists of a porous shape, usually kaolin, a transparent dense bond permeating the skeleton, and a thin glossy glaze, the petuntse, on the outside. Glazes were used in Egypt prior to their use in China and were brought to the latter country from Egypt sometime in the 2nd Century B.C. China soon surpassed other countries in the art of glazing, developing many colors and obtaining mostly the effects of reducing atmospheres which existed in their underground kilns. The development of Chinese pottery through the successive dynasties is outlined from the Han dynasty (206 B.C. to 220 A.D.) when the first glazed ware was produced, up through the T'sing dynasty (1624–1795) which saw the perfection and culmination of the development of the art of Chinese pottery. Many pieces from the Han dynasty were shaped on the wheel. The development of graceful shapes and ceramic figures is described. The Sung dynasty saw the introduction of crackled ware and perfection of colored glazes produced under reducing conditions. Porcelain stoneware was also instigated during this period. True porcelain was first made early in the Ming dynasty (1368–1644), following the celadons of the Yuan dynasty (1280–1368). A description of the body and glaze of some early Han porcelaneous pottery fragments is given, including chemical analyses of them. The glaze is apparently a mixture of the body material and limestone. W.W.M.

Pottery vessels of the T'ang dynasty. WILLIAM KING. *Studio*, **97** [402], 39–42 (1930).—The high quality of Chinese workmanship of the 7th and 8th Century, the T'ang dynasty, is exemplified by a variety of objects done in many techniques contained in notable private collections. Pieces incised, modeled, combed, and painted are described and illustrated. E.B.H.

Italian decorative art at Monza. CARLO TRIDENTI. *Studio*, **96** [399], 50 (1930).—Italy has recently realized that modern needs have created new art styles with a utilitarian criterion and has developed a modern and at the same time typically Italian art style shown at the Monza Triennial Exhibition this summer. A definite symbol of the sense of Italy is the room full of glass beakers, etc., the finest specimens of the Pompeian glassblower's art. Illustrated. E.B.H.

Pottery of humanism. Italian majolica. BERNARD RACKHAM. *Studio*, **97** [402], 21–24 (1930).—In the history of European pottery majolica was of supreme importance in determining the adoption of painting as the normal mode of ceramic decoration, adopted from the Islamic world. This was contemporary with the Italian supremacy in painting, the pigments in beauty and durability being welcomed by a race of born painters. The five master colors used were blue, yellow, green, purple, and orange. The majolica of Orvieto, Faenza, Deruta, and Gubbio stands out as types made in those places. E.B.H.

Inca pottery. FRANK DAVIS. *Illus. London News*, **177**, 732 (1930).—Inca pottery resembles ancient Egyptian art in the attention paid to the details of the face, the rest of the body being only sketchily indicated. Illustrated. H.H.S.

Story of Dutch ceramics. FRANK DAVIS. *Illus. London News*, **177**, 776 (1930).—An illustrated account is given of Dutch tile pictures and delftware. H.H.S.

Discoveries at Tell Halaf. MAX VON OPPENHEIM. *Illus. London News*, **177**, 706–709, 760–61 (1930).—O.'s excavations since 1911 have resulted in remarkable finds of Subarean-Hittite civilization of the 3rd millennium B.C. in Upper Mesopotamia. Illustrated. H.H.S.

Prehistoric discovery at Vinca, Serbia. M. M. VASSITS. *Illus. London News*, **177**, 664–67 (1930).—Vinca, a village on the Danube, has revealed itself as a center of Aegean civilization 2000 years B.C. Twenty-two photographs of pottery, etc., are included. H.H.S.

Babylonian ceramic art. ANDRAE. *Tonind.-Ztg.*, **54** [100], 1561 (1930); for abstract see *Ceram. Abs.*, **10** [2], 94 (1931). M.V.K.

Miniature tomb furniture. LESLIE RICHARDSON. *Bull. Met. Mus. Art*, **25** [10], 222–23 (1930).—Twenty-five miniature figures and utensils of the T'ang dynasty (618–906 A.D.) have recently been added to the collections of Chinese pottery. The glazed pieces consist of two whistles, four jars, a cup, incense burner, and a pilgrim bottle. They are of white clay with soft lead silicate glazes, and are skilfully executed. The unglazed group consists of horses, camels, seated musicians, and standing female figures. These figures, with their various styles of costumes and head-dresses, represent the most interesting type of tomb figurines. A.A.A.

Bequest of Theodore M. Davis. ANON. *Bull. Met. Mus. Art*, **25** [11], 230–31 (1930).—The bequest of Theodore M. Davis under litigation since 1915 has finally been confirmed. The collection includes antique glass and Near Eastern pottery. Examples of early Arabic glass are important and the group of Near Eastern pottery is large and representative of ceramic ware of the 12th to 14th Centuries as well as of later periods. A.A.A.

Terra cotta statuette. CHRISTINE ALEXANDER. *Bull. Met. Mus. Art*, **25** [11], 242–44 (1930).—An important addition to the Museum's collection of terra cotta is shown in the Room of Recent Accessions. Two front views of a female figure holding a pigeon, each made in a mold, are joined back to back. The statuette has been broken and restored. The original red color is well preserved except on the flesh and hair and on the birds. This example probably came from western Sicily and is considered to be one of the finest known. The pigeon is associated with the love goddess and this may be the goddess herself or a votary bringing her an appropriate gift. The whole effect is sculptural, comparing favorably with contemporary bronzes. A.A.A.

Recent accessions in the classical department. G. M. A. RICHTER. *Bull. Met. Mus. Art*, **25** [12], 279–80 (1930).—Three important acquisitions are being shown in the Room of Recent Accessions: (1) A "Melian" relief, a terra cotta product of the first half of the 5th Century, represents the return of Odysseus. This important piece has been listed as lost in recent publications and the Museum just acquired it from a private collector. Other figures in the relief besides Odysseus are Penelope, her son Telemachus, the herdsman Eumäius, and Laertes, each in a characteristic attitude. The figures are finely modeled and traces of the original colors are still preserved. (2) A red-figured Lekythos, dated about 430 B.C., is decorated with a simple scene of a woman dressing. It is so well painted that it becomes a great work of art. The artist can be identified as the Eretria painter, so-called after one of his masterpieces, the Epinetron from Eretria, in the National Museum, Athens. (3) A vase in the form of a female head, dated about 480 B.C. The Athenian potter occasionally made his vases from molds in the form of human or animal heads. The new example acquired by the Museum is finely modeled and takes its place with the latest of the Athenian maidens on the Acropolis. A.A.A.

The Stuttgart museum. OTTO PELKA. *Sprechsaal*, **63** [47], 889–93 (1930).—P. describes the great collection of beautiful porcelain objects of the 18th Century exhibited in the Stuttgart museum in Germany. Illustrated. M.V.K.

BOOKS

The Mound-Builders. H. C. SHETRONE. xx + 500 pp. Appleton, London, 1930. Price 30s. Reviewed in *Times Lit. Supp.*, **29**, 852 (1930).—A connected account is given of the 10,000 earthworks which spread from the Great Lakes to the Gulf of Mexico. The Ohio area makes the nucleus of the book. H.H.S.

Romance of Archaeology. W. H. BOULTON. x + 246 pp. Sampson, Low & Co., London, 1930. Price 6s. Reviewed in *Times Lit. Supp.*, **29**, 867 (1930).—An account is given of exploration in Egypt and Hither Asia from the earliest discoveries to the present day. H.H.S.

Romance of Archaeology. R. V. D. MAGOFFIN AND E. C. DAVIS. xv + 348 pp. G. Bell & Co., London, 1930. Price 18s. Reviewed in *Times Lit. Supp.*, **29**, 891 (1930).—The earliest dated monument on the American Continent is said to be a Mayan object of 98 B.C. H.H.S.

Art and Culture of Ancient Peru. MAX SCHMIDT. Propylaen-Verlag, Berlin, 1930. Price $11.00. Reviewed in *Times Lit. Supp.*, **29**, 880 (1930).—Among the centers of pottery manufacture described are Truxillo, Nasca, Chancay, Huacho, Recuay, Pachacamac, and Ica. H.H.S.

Dictionary of Marks and Monograms of Delft Pottery. JEAN JUSTICE. 171 pp. Reviewed in *Times Lit. Supp.*, **29**, 867 (1930); see also *Ceram. Abs.*, **9** [4], 254 (1930). H.H.S.

PATENTS

Design for plate, etc. URASABURO TOMITA. U. S. 82,858, Dec. 16, 1930.

Design for bathtub. CARMI J. STEELE. U. S. 82,856 and 82,857, Dec. 16, 1930.

Design for goblet, etc. GEORGE SAKIER. U. S. 82,909, Dec. 23, 1930; EDWARD J. SCHAUB. U. S. 82,910, Dec. 23, 1930.

Design for flower bowl. THOMAS CLARENCE HEISEY. U. S. 82,888, Dec. 23, 1930.

Design for glass plate. THOMAS CLARENCE HEISEY. U. S. 82,887, Dec. 23, 1930.

Design for water-closet bowl. HARRY F. WEAVER. U. S. 82,963, Dec. 30, 1930.

Design for drawer pull. JAMES A. MCBRIDE. U. S. 82,949, Dec. 30, 1930.

Design for tumbler. JAMES M. PAYNE, JR. U. S. 82,953 and 82,954, Dec. 30, 1930.

Design for jar. EDWIN WENDELL FUERST. U. S. 82,933, Dec. 30, 1930.

Design for tile block. BECHER B. BOLTON. U. S. 82,970, Jan. 6, 1931.

Design for lavatory. CARL H. ZWERMANN. U. S. 83,025, Jan. 6, 1931.

Cement, Lime, and Plaster

Studies of the lime ratio in cement. ALTON J. BLANK. *Rock Prod.*, **33** [25], 58–61 (1930).—B. presents and discusses some collected data on the influence of the lime ratio $\left(\frac{CaO}{SiO_2 + R_2O_3}\right)$ upon manufacture and quality of cement together with his conclusions. Charts are given showing that the clinker output of kilns decreases and the fuel consumption per unit produced increases with an increase in lime ratio; also, the output of the preliminary and fine grinding mills is shown to vary directly as the lime ratio, while the power consumed in grinding varies inversely. One chart shows the per cent free lime and Le Chatelier expansion of the cement to increase with an increase

in lime ratio, and the percentage of sound cement pats is shown to drop off after a lime ratio of 2.04 is passed. In general the cements of lower lime ratio are safer than those of higher lime ratio. W.W.M.

Free lime, soundness, and strength. A. GUTTMANN AND F. GILLE. *Zement*, 19 [46], 1078 (1930); *Rock Prod.*, 33 [26], 90–91 (1930).—Upon the basis of experiments on clinker of varying chemical composition and clinkered under varying conditions, the authors can confirm the statements of Haegermann concerning the numerical connection between the free-lime content of the cement and its behavior in the cold water and also in the boiling test (see *Ceram. Abs.*, 9 [3], 159 (1930)). Reference may be made to Wm. Lerch, who in his studies on the action of free lime upon the soundness, came to the conclusion that cements with a content of less than 1% free lime may be considered, in general, as sound, whereas in the presence of more than 3% free lime unsoundness appears usually in the pat. W.W.M.

Determination of soluble silica in pozzuolana cements. G. BAIRE. *Chim. & ind.* [Special No.], pp. 298–300 (March, 1930).—The usual method for the determination of soluble SiO_2 in Portland cements (solution in HCl under definite conditions) gives low results with pozzuolana cements either alone or in admixture with Portland cement, because of incomplete decomposition and solution of silicates which are enclosed in SiO_2 insoluble in acids. The Florentine method also gives low results. The Cayeux method (treatment of the sample with cold 20% KOH for 20 hrs. and then for 4 hrs. at 50 to 65°) gives good results with straight pozzuolana, but not with mixtures containing Portland cement because the silicates are incompletely decomposed. For mixed pozzuolana-Portland cements, B. proposes combining the 2 methods as follows: treat 1 g. of sample with 100 cc. H_2O, add 25 cc. 1:1 HCl with stirring, rapidly heat till the solution is light yellow, filter immediately through an ashless filter, wash 6 times with boiling water, wash the precipitate into an evaporating dish, incinerate the filter and add to the precipitate, dry almost completely, add 100 cc. of 20% KOH (density 1.177), let stand 20 hrs. with occasional stirring, keep 4 hrs. at 50 to 65°, decant the solution, washing 4 or 5 times with cold water by decantation, filter, wash 5 times with boiling dilute HCl (1:9) and finally 7 or 8 times with boiling water; let the decanted solution and decanted washings stand several hours, decant the clear solution, filter the precipitate and wash as above, ignite the 2 filters, fuse with $Na_2CO_3 + K_2CO_3$, and determine SiO_2 in the melt, giving insoluble SiO_2 in the sample. Soluble SiO_2 is obtained by difference from the total SiO_2. (*C.A.*)

Effects of magnesium oxide on clinker and cement. A. J. BLANK. *Rev. mat. constr. trav. pub.*, No. 253, pp. 381–83 (1930).—(1) Cements high in magnesia: These cements form small nodules which greatly increase the wearing of the kiln lining. Such cements are ordinarily unstable and disintegrate after 7 days or more. (2) Cements fairly high in magnesia: Nodules are also formed in the kiln. The cements are of doubtful stability. (3) Cements with magnesia just exceeding the specifications: These cements behave well in the kiln although the clinker is a bit more voluminous than ordinarily. The cements are stable and have good strength. (4) Cements low in magnesia: These cements are satisfactory in nearly every way. A.J.M.

Influence of monocalcium phosphate on hydration of cements. K. KOYANAGI. *Jour. Soc. Chem. Ind.* [Japan], 33 [7], 276–77*B* (1930); *Tonind.-Ztg.*, 54 [98], 1534 (1930).—Monocalcium phosphate greatly affects cement and concrete in fertilizer plants. Very small quantities of monocalcium phosphate retard the setting process of cement because the hydration of calcium aluminate is prevented. Phosphate shows a great affinity to lime during the formation of insoluble dicalcium and tricalcium phosphates. When the quantities present are small, the monocalcium phosphate changes completely in the first stage of hydration into triphosphate, which makes it harmless. M.V.K.

Hydrates of calcium sulphate. F. KRAUSS AND G. JÖRNS. *Tonind.-Ztg.*, **54** [94], 1467–69; [95], 1483–84 (1930).—The authors discuss the latest researches on hydrates of calcium sulphates. They found that for the preparation of the pure $^1/_2$ hydrate, raw gypsum must be quickly heated to its decomposition temperature then rapidly cooled to the temperature at which the transfer of the 2 to the $^1/_2$ hydrate takes place. M.V.K.

Tricalcium silicate. R. BRILL. *Rock Prod.*, **33** [22], 78 (1930); for abstract see *Ceram. Abs.*, **10** [2], 99 (1931). W.W.M.

Tricalcium silicate. A. GUTTMANN AND F. GILLE. *Rock Prod.*, **33** [22], 78 (1930); for abstract see *Ceram. Abs.*, **10** [2], 99 (1931). W.W.M.

Estimation of free calcium hydroxide in set cements. G. E. BESSEY. *Rock Prod.*, **33** [25], 61 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1019 (1930). W.W.M.

Gypsum and gypsum products manufacture. VI. S. G. MCANALLY. *Rock Prod.*, **33** [25], 46–47 (1930).—A table showing the weakening effect of water immersion on the tensile strength of set fibered plaster and a table of specific gravities, specific heats, and volumes and voids of various calcined gypsums are included in the paper. For Part V see *Ceram. Abs.*, **10** [2], 97 (1931). W.W.M.

Protecting concrete from steam and acids. ANON. *Feuerungstechnik*, **18** [23–24], 241 (1930).—The small resistance of ordinary cement to chemicals is due to its lime content. Concrete protective agents must therefore react with the lime of cement to form insoluble compounds. Blast-furnace slag and other substances rich in silicic acid added to cement form insoluble calcium silicates with the lime of cement. Bituminous coatings only give sufficient protection against wet steam and chemicals except acids. The materials best adapted for such coatings are natural asphalts. Since they are expensive, petroleum asphalts (distilled and not refined residues), which have properties and a composition similar to natural asphalts, are substituted. Where there are no high-temperature differences and only weak acids, coal tar can be used. Resin is also used. In many cases it is better to use pastes instead of liquid coatings. Besides the bitumen, these pastes contain filling materials, *e.g.*, asbestos, which make the coating stable on heating and mechanically resistant. In general, the slower the coating dries the more elastic it becomes and the more solidly it adheres to cement. M.V.K.

Anhydrite plasters and cement. A. E. FLYNN. *Bull. Can. Inst. Mining Met.*, (1930); *Rock Prod.*, **33** [26], 51 (1930).—The paper, presented by F. at the annual meeting of the Mining Society of Nova Scotia, gives detailed reports of experiments performed with natural and artificial anhydrite and shows that a cheap cement can be manufactured from anhydrite. W.W.M.

Obtaining high slurry finenesses. J. GUERIN. *Ciment*, **35** [7], 262–66 (1930); *Pit & Quarry*, **21** [3], 67 (1930).—G. recommends filtering the slurry (a number of filtering devices are described) and returning the oversize particles to the mill; this has the additional advantage of removing part of the water from the slurry, and further, can be arranged to increase mill output by increasing the feed and catching all oversize in the filters. E.P.R.

Thermal efficiency of the kettle process for calcining gypsum. WALLACE C. RIDDELL. *Rock Prod.*, **33** [26], 66 (1930).—R. states that the kettle process for calcining gypsum is more efficient than is generally supposed. He gives a table showing that the calculated efficiencies of kettles in several gypsum plants vary from 45.6 to 55.1%. W.W.M.

First closed-circuit wet-process cement mill. ANON. *Rock Prod.*, **33** [25], 65–67 (1930).—Figures and data are given to show that grinding capacity has been increased, power consumption and consumption of grinding media has been decreased, and fineness of grinding has been improved by the change. Strength of the finished cement has been

improved by the new process and kiln capacity has been increased. The filter installation is described and operating data on the filters is given. Illustrated. W.W.M.

Researches on rotary kiln in cement manufacture. IX. GEOFFREY MARTIN. *Rock Prod.*, **33** [25], 54–55 (1930).—Complicated physical and mathematical proofs and a simple table based on these computations are presented. **X.** *Ibid.*, **33** [26], 49–51 (1930).—Calculation of the quantity of pure dry raw material required to make 100 lb. of Portland cement clinker is given. For Part VIII see *Ceram. Abs.*, **10** [2], 98 (1931). W.W.M.

Coolers in cement-firing kilns. ERICH SCHIRM. *Tonind.-Ztg.*, **54** [96], 1493–94; [97], 1507–10; [98], 1521–23 (1930).—In the cooler the hot clinker from the firing zone heats the air used for firing. Direct and indirect methods of cooling are used. In direct cooling the cooling agent comes in direct contact with the clinker. In indirect cooling the heat is given up through the walls. Cooling with air is most frequently used. Cooling with water and with fresh ware is also used. Coolers are distinguished according to their construction: drum, shaft, rost, spiral tube, and cell coolers. Drum coolers are especially adapted for revolving furnaces. Their great disadvantage is that the air leaving the cooler is full of dust. The shaft cooler is used with shaft kilns. S. describes the construction and working of other systems of coolers, including some types used in the U.S. M.V.K.

Machines for testing solidity of cements. ANON. *Tonind.-Ztg.*, **54** [99], 1541–42 (1930).—Standard machines for determining the tensile strength and resistance to pressure of Portland, iron-Portland, and blast-furnace standard cements are described. M.V.K.

Guide to studies of cement made in 1929. C. R. PLATZMANN. *Rock Prod.*, **33** [26], 90 (1930); for abstract see *Ceram. Abs.*, **10** [2], 100 (1931). W.W.M.

International Cement Congress. C. G. FONTANA. *Giorn. chim. ind. applicata*, **12** [10], 506–507 (1930).—The first International Cement Congress was held at Liége, August, 1930. M.V.K.

Cement used by Romans. ANON. *Pit & Quarry*, **21** [6], 58 (1930).—Contrary to a popular idea, the ancients do not seem to have been acquainted with Portland cement of the kind now universally used. The cement used by the Romans was not a clinkered product. It was made from powdered volcanic ash and slaked lime which were mixed together and called pozzuolana. It had many of the elements, however, of the present Portland cement. E.P.R.

BOOK

Gypsum Industry of Canada. L. H. COLE. Dept. of Mines, Ottawa, 1930. 164 pp. Reviewed in *Chem. News*, **141** [3682], 302 (1930).—This compilation with maps and illustrations, gives an authoritative survey of one of the Dominion's most important nonmetallic mining undertakings. The various sources and methods of mining and the mill flow sheets are given in detail. See also *Ceram. Abs.*, **10** [1], 65 (1931). G.R.S.

PATENT

Manufacturing Portland cement. GUY S. LA FORGE. U. S. 1,784,840, Dec. 16, 1930. Those steps in the process of producing Portland cement which consist in mixing together raw calcareous material, raw argillaceous material, and unground Portland cement clinker, and subjecting the mixed materials to a pulverizing operation are described.

Enamels

Easily-fusible enamels. VIELHABER. *Emaillewaren-Ind.*, **7** [48], 379–80 (1930).—The proportion between the flux ingredient and refractory ingredient of an enamel mixture, and not necessarily the high flux content, as is commonly believed, determines

the fusing point. (1) *Feldspar-soda.* The lowest fusing point is about 675°C with 50 parts feldspar and 50 parts calcined soda. The composition of the feldspar has an influence. (2) *Feldspar-borax.* The lowest fusing point lies at 630°C with 20 parts feldspar and 80 parts borax, or 40 parts feldspar and 60 parts borax. (3) *Feldspar-potash.* The lowest fusing point lies at 800°C with 20 parts feldspar and 80 parts potash and 50 parts feldspar and 50 parts potash. (4) *Feldspar-cryolite.* The lowest fusing point is at 830°C with 70 parts feldspar and 30 cryolite. (5) *Quartz-soda.* While 30 parts quartz and 70 parts soda fuse at 980°C, mixtures of 10 parts quartz and 90 parts soda, and 70 parts quartz and 30 parts soda fuse at 820°C. (6) *Quartz-borax.* Lowest fusing point is 680°C with 25 parts quartz and 75 parts borax. (7) *Quartz-potash.* At 820°C, a mixture of 20 parts quartz and 80 parts potash fuses; with 70 parts quartz and 30 parts potash the softening point is at 900°C. The following mixtures are of interest: (*a*) 80 parts feldspar and 20 parts fluorspar have a softening point of 1000° C; (*b*) 80 parts feldspar and 20 parts limespar have a softening point of 1125°C; (*c*) 80 parts feldspar and 20 parts litharge have a softening point at 800°C; (*d*) 80 parts soda and 20 parts bone ash have a softening point at 800°C; (*e*) 80 parts soda and 20 parts tin oxide fuse at 750°C. These mixtures with an addition of a third component have a lower fusing temperature: (1) 50 parts feldspar, 33 parts borax, and 17 parts limespar fuse at 725°C; (2) 50 parts feldspar, 33 parts borax, and 17 parts cryolite fuse at 700°C; (3) 50 parts feldspar, 33 parts borax, and 17 parts litharge fuse at 575°C. (4) 50 parts feldspar, 33 parts borax, and 17 parts barium carbonate fuse at 575°C.

M.V.K.

Unfused enamel. ANON. *Emaillewaren-Ind.*, **7** [44], 62–64; [48], 65–68 (1930).—An unfused enamel has great advantages over the ordinary-fused enamel: (1) fusing, an expensive process, is avoided; (2) there is no granulation; and (3) the whole process of enameling is simplified. Any enamel which is not too fusible can be used for such raw enamels. The initial materials must be ground as fine as possible although substances like borax and soda can be less finely ground since they dissolve in water. The metallic oxides such as cobalt and nickel oxides must be especially finely ground. The grinding requires 4 or 5 hr. in an ordinary mill; the addition of admixtures is the same as in ordinary enamels except that the clay content is increased. If the enamel is too hard, its quartz content must be lowered. The drying of the thin raw enamel layer is the most important step. In principle it requires a rapid, hot drying as the soluble salts absorb water and crystallize, and heat calcines these salts. The enamel layer is excessively hard and adheres very well to the plate. The fusion in such an enamel is only partial but as this enamel is much more resistant it permits several returns into the fire. The composition of an unfusible enamel giving very good results is as follows: 16.50 parts borax, 10.50 parts feldspar, 12.00 parts quartz, 1.50 parts fluorspar, 1.50 parts soda, 0.75 parts saltpeter, 0.06 parts manganese dioxide, 0.40 parts green nickel oxide, 0.20 cobalt oxide, and 4.50 parts clay.

M.V.K.

Effect of variations in composition on properties of vitreous enamels. ANON Bur. Stand., *Tech. News Bull.*, No. 164, pp. 120–21 (1930).—In the August, 1930, *Bulletin* (see *Ceram. Abs.*, **10** [1], 19 (1931)) it was reported that enamels having identical calculated chemical compositions but prepared from different raw mixes had shown a distinct difference in softening temperature. Repetitions of the experiment which have been carried out since that date confirm the observation that appreciable differences in fusibility occur when enamels are prepared in refractory crucibles and are agitated during smelting by continuous rotation of the crucibles. When smelted in stationary refractory crucibles with occasional stirring, the differences between enamels were less noticeable. When the smelting was carried out in platinum crucibles no appreciable effect of variations in raw materials to give the same calculated melted composition was

observed by means of cone-deformation tests or fusion-block tests. The batch mixes which were used to obtain the described results are given. R.A.H.

Cryolite and feldspar. VIELHABER. *Emaillewaren-Ind.*, **7** [50], 395–96; [51], 403–404 (1930).—Cryolite is used to give a high expansion and elasticity to enamels. Cast enamels whose expansion cannot exceed 320 contain less cryolite than plate enamels. Cast enamels seldom contain more than 7% cryolite (only the wet enamels) while cast powder enamels contain little or no cryolite. Plate enamels have an expansion up to 380 permitting a greater addition of cryolite. For cooking utensils where the enamel is elastic but less expansive, additions of cryolite amount to 3 to 3.5%. Sometimes mixed enamels composed of ground and white enamels are ground together and 10 to 12% cryolite added; owing to the differences in fusibility such enamels tend to be porous. Utensils not used for cooking contain up to 16% cryolite. Fluorspar is similar to cryolite in action and increases the adhering power of an enamel. Most plate and cast enamels contain it, especially the frit-ground enamel for casts. M.V.K.

Story of vitreous enamel. F. M. BURT. *Gas Age-Rec.*, **66** [24], 951–54 (1930).—In conducting a discussion of the enamel industry and its association with various household appliances such as kitchen stoves, etc., B. takes up quite a few questions that are most often asked about enamel products and their production and answers each in a concise manner. Some information about the formation and activities of the new Porcelain Enamel Institute, Inc., is also presented. Illustrated. See also *Ceram. Abs.*, **10** [2], 103 (1931). E.J.V.

Thickness of enamel layers. ANON. *Emaillewaren-Ind.*, **7** [48], 68–69 (1930).—An enamel should be applied as thin as possible. Enamel is a bad conductor of heat and during cooling the surface of the enamel loses its heat very rapidly and irregularly while the cast is still hot. If the difference of temperature between the surface and the interior is too great, the enamel cracks. A thin layer transfers heat much quicker and lowers the difference of temperature; the tensions are decreased and the enamel is more solid. On the other hand, an enamel which is too thin is not sufficiently resistant. For plates of 0.5 to 1.0 mm. thickness, the enamel should be from 0.3 to 0.6 mm. thick; for thicker plates the enamel can be 0.8 mm. in thickness. M.V.K.

Routine analysis of cast irons and iron-foundry raw materials. ARTHUR SMITH. *Foundry Trade Jour.*, **41** [691], 357–60 (1929).—Cast irons are essentially complex iron-carbon alloys containing greater or less quantities of other elements according to their purity. The strength and general physical properties of any cast iron depends not only on the amount, size, and distribution of the free or graphitic carbon, but also on the percentage of carbon chemically combined as iron carbide as well as the physical structure and arrangement of this carbide. The phenomenon of cooling molten cast iron closely follows phase-rule principles. S. discusses cooling briefly. A representative sample is difficult to obtain as graphite is reduced to a fine powder under the drill. Total carbon and graphite are determined and combined carbon obtained by difference. The direct combustion method is recommended for the determination of total carbon. The method and apparatus are described in detail. The furnace is a combustion tube furnace electrically heated. S. recommends fireclay tubes and cheap combustion boats made of fire clay with a bottom layer of pure silica or alundum. The essential features for the absorption apparatus are given. S. favors a solid absorbent. The details of the combustion train are listed. The procedure for a complete analysis is given. The "Ströhlein" apparatus for the determination of carbon content in iron and steel was also satisfactory for this type of work. The estimation of graphitic carbon is made by dissolving the sample in acid, thus liberating the free carbon which is filtered on carbon-free, purified, ignited asbestos. The graphite is carefully washed free from iron salts and subsequently burned in oxygen as described for total carbon. The procedure is

given in detail. The microscope may be used to obtain approximate analyses for combined carbon. The method of Arnold and Read for isolating the amount of carbide of iron from carbides of manganese, chromium, etc., is given briefly. The estimation of carbon in ferro alloys is obtained by the direct combustion method with oxygen. In some cases higher temperatures and oxidizing agents are advisable. H.W.A.

Practical notes on foundry sands. J. L. FRANCIS. *Foundry Trade Jour.*, **43** [740], 281–84 (1930).—The essential physical properties of natural sands employed are discussed in some detail. The control of raw material and prepared sand is given. Tests for bond strength, permeability, and grain size are described. H.W.A.

Reactions in pickle-room solutions. ANON. *Better Enameling*, **1** [8], 20–24 (1930).—Fatty acid types of oils should be used because of the ease with which they may be emulsified and saponified in the cleaning process. The highly-alkaline cleaning solutions at the boiling point convert these oils into soap which dissolves in the water leaving the surface of the metal clean. The metal is then pickled in either hydrochloric or sulphuric acid to remove scale and rust. The concentration of the sulphuric acid is usually between 6.5% and 10%. The temperature is kept between 140°F and 160°F. The pickled ware is neutralized to counteract the action of the acid remaining after the rinse. The ferric sulphate, formed by the action of the acid and air on the metal, reacts with the neutralizer to form ferric hydroxide as represented by the following equation: $Fe_2(SO_4)_3 + 3Na_2CO_3 + 3H_2O \rightarrow 2Fe(OH)_3 + 3Na_2SO_4 + 3CO_2$. The acid on the ware reacts with the neutralizer as follows: $H_2SO_4 + Na_2CO_3 \rightarrow Na_2SO_4 + H_2O + CO_2$. W.C.O.W.

Buying or making frit. FRED MCC. BURT. *Ceram. Ind.*, **16** [1], 22–23 (1931).—B. discusses the advisability of buying enamel frit and of making it in the plant. Of 300 plants doing enameling in the U.S. and Canada about 100 of them make their own enamel frit. There are plants changing from one method to the other continuously. Enameling in this country started with kitchen ware about 60 years ago and became an important industry about the end of the last century. Buying enamel frit is a comparatively recent step in the industry. Before this, enamels were made at the plant from secret formulas and troubles often occurred because of a lack of uniformity. Variables must be eliminated to obtain good products. W.W.M.

Enameling troubles. ROBERT B. SCHAAL AND DONALD H. FULLER. *Ceram. Ind.*, **15** [6], 605–14 (1930).—The parts played by the sheet maker, the enamel maker, and the shop man in enameling development are described. It is pointed out that in spite of progress, troubles remain. The article is limited to troubles outside of those directly attributable to shop conditions. Special cases of black specks, fishscale, and copperheads are treated. The authors state that black specks are directly caused by the evolution of gas from the steel and discuss the effect of ground coat composition on the extent of the specking. Fishscale is traced to a spongy ground coat due to gas evolution and the results of experiments to determine the effect of ground coat composition on fishscale are presented. Copperheading, while primarily due to gas evolution, is controlled by ground-coat composition. W.W.M.

Causes of frit contamination. ANON. *Amer. Enameler*, **3** [8], 9; [10], 5–6 (1930).—Most frit contamination takes place after the frit is smelted. Monel or other noncorrosive metal conveying and handling machinery has practically eliminated in up-to-date frit manufacturing plants a former source of harmful contamination. Moisture- and dust-proof bags have eliminated another source of contamination. These bags, however, must be carefully dusted before being emptied into the mill or storage bin, and should not be stored near sandblast or grinding rooms, or in oily places. Mill additions are sometimes the source of frit contamination, particularly the clay. Only the very best clay should be used for weighing and charging, and mill additions should

be thoroughly cleaned when changing from frit of one color to another. Badly-worn mill linings cause serious contamination and should always be replaced or repaired as soon as any indications of trouble arise. Enamel storage tanks and spray cans should be covered as much as is possible. The source of air used in driers must be clean, so that no dust or other dirt is blown onto the wet enamel. Doors and sills of box-type furnaces should be cleaned regularly. Firing tools should be made of a nonscaling, noncorrosive metal. Air lines should be washed carefully to avoid contamination with water or oil. Air compressor intakes should be located away from dust. Finally, "90% of enameling plant troubles can be swept out with a broom." J.N.U., Jr.

Rust spots on ground enamels. Anon. *Emaillewaren-Ind.*, **7** [49], 386–87 (1930).—Borax and soda combined with phosphoric acid are often used effectively in preventing rust; in this case the ground coating should be dried as quickly as possible. The reason for the appearance of rust is the disintegration of sulphides (iron and manganese sulphides). An addition of salmiac accelerates the appearance of rust, and admixtures of quartz to the mill in plate enamels easily produce a formation of rust spots. "Rostex" is a salt which entirely prevents the formation of the red ferric hydroxide and does not affect the enamel. An 0.1% solution of this salt is added to the mass. Tests with "Rostex" are described. M.V.K.

Cleaning cast iron. Anon. *Better Enameling*, **1** [8], 16–18 (1930).—Castings for enameling should be stored in a warm dry room to prevent rusting. Before enameling they must be thoroughly cleaned to remove rust, scale, and foreign material of any kind. This is done by sandblasting in a sandblast room on a sandblast table or in a revolving barrel, depending on the type of casting employed. W.C.O.W.

Scientific principles of casting metals. H. C. Dews. *Foundry Trade Jour.*, **43** [741], 303–304 (1930).—This paper reviews some of the scientific considerations which govern the production of perfect castings. H.W.A.

Firing cast iron in a continuous furnace. Anon. *Ceram. Ind.*, **16** [1], 16–21 (1931).—The Peerless Enamel Products Co. has installed a continuous electric furnace for firing wet-process, cast-iron shapes weighing from 1 to 30 lb. The firing time is 6 min. A continuous gas-fired furnace is operated for sheet ware. The plant capacity is 30,000 lb. of enameled cast iron and 12,000 sq. ft. of enameled sheet ware per day. The electric furnace has reduced the production cost of cast-iron ware 18% and improved its appearance about 50%. This kiln has a power consumption of 225 kw. and a firing chamber 24 ft. long. The temperature is automatically controlled within 3°. The equipment, operations, and labor requirements of the plant are given and a list of materials used. Illustrated. W.W.M.

New enamel kiln. Hermann Lauff. *Emaillewaren-Ind.*, **7** [48], 377–79 (1930).—L. describes a new continuous enamel kiln with a double muffle and an added preheating or cooling muffle (the so-called adjustable chamber) heated by generated gas, the floor and walls of the muffle being heated first. Waste gases are used for preheating the air required for firing. The muffle is made of highly-refractory electrocorundum which is completely impermeable to gas. The adjustable chamber or preheating and cooling muffle is used for drying the enamel coatings. The kiln and the adjustable chamber are insulated with kieselguhr. The consumption of gas is very low. The kiln can be heated by illumination, coke, kiln gas, or oil. M.V.K.

Enamel mills. Anon. *Emaillewaren-Ind.*, **7** [49], 385–86 (1930).—A discussion of different kinds of enamel mills is given. The necessity of finding a more efficient liner harder than porcelain is urged. A description of American mills using rubber coatings is given. M.V.K.

Written specifications for processing in an enamel plant. Roy. D. Beck. *Ceram. Ind.*, **16** [1], 30–40 (1931).—B. says that in order to obtain good products consistently

and keep costs down, all processes should be controlled by a standard set of specifications. Processing instructions and specifications (with reference to the mill room, including all operations, tests, specifications, and duties) actually used in a well-known vitreous enamel plant constitute the greater portion of the article. W.W.M.

Designing a mass-production foundry. N. C. BLYTHE. *Foundry Trade Jour.*, **43** [739], 267–68 (1930).—The article describes (1) lay-out and equipment for the mass production of castings which have to be machined, (2) pass pressure, and (3) soundness tests. H.W.A.

Minimum floor space in enameling plant. ANON. *Ceram. Ind.*, **15** [6], 569–72 (1930).—The equipment and processes used at the enameling plant of the Westinghouse Electric & Mfg. Co. at Mansfield, Ohio, are described and illustrated. A unique system of overhead conveyers, driers, and mechanical handling makes possible maximum production in a minimum amount of space. W.W.M.

Construction of refrigerator linings. C. H. WOLFF. *Jour. Amer. Ceram. Soc.*, **14** [2], 148–61 (1931); for abstract see *Ceram. Abs.*, **9** [3], 163 (1930).

Enameled refrigerator withstands fire. ANON. *Atlantic Highlands Jour.; Better Enameling*, **1** [8], 31–33 (1930).—A Seeger porcelain-enameled cabinet refrigerator withstood a fire so fierce that 14-in. steel girders were warped and bent. On examination the following morning a large piece of ice was found in the refrigerator. W.C.O.W.

BOOK

Impurities in Metals. COLIN J. SMITHELLS. John Wiley & Sons, New York, 1930. $5.00. Reviewed in *Mining & Met.*, **12** [289], 18 (1931); for abstract see *Ceram. Abs.*, **10** [2], 103 (1931). E.J.V.

PATENTS

Producing vitreous enamels. CHARLES J. KINZIE. U. S. 1,785,777, Dec. 23, 1930. In the preparation of a slip for vitreous enamels and glazes from mill liquor containing alkaline substances, the step which consists in treating the liquor with a salt of one of the metallic elements in Group IV, Subgroup *A*, of Mendelejeff's classification having a molecular weight below 100 to neutralize the alkaline substances and produce a hydrate precipitate of the element introduced as the salt is described.

Enameling metal articles. ALVIN G. SHERMAN AND ALBERT MEADOWS. U. S. 1,787,175, Dec. 30, 1930. In an enameling mill of the type having a rotary furnace for consecutively firing metal articles at a relatively high heat and means for receiving the fired articles, the combination with the firing furnace and the receiving means of a conveyer positioned therebetween, one end of the conveyer being adjacent the outlet of the furnace and the other end adjacent the receiving means, the surface of the conveyer being relatively flat whereby to receive the hot fired articles and to straighten the same, the length of the conveyer between the furnace and the receiving means being such as to insure cooling and fixing of the straightened articles whereby to insure that the articles will not be affected when transferred from the straightening conveyer to the receiving means.

Enamels. W. E. DOUGHERTY. Brit. 336,797, Dec. 10, 1930. Titanium dioxide is used as an opacifier for enamels that do not contain fluorine. Calcium carbonate or another suitable salt of calcium, barium, strontium, or magnesium, is preferably added to the batch to intensify the opacity produced by the titanium. If the titanium tends to produce a yellowish enamel, small amounts of zirconium oxide or tin oxide are added to secure the desired whiteness. The titanium may be added to the foundation enamel which is applied directly to the surface of the metal article and it is stated that it will not cause blistering. For the foundation enamel, 2 to 4% of titanium dioxide is added

to the batch materials, and when the mixture has been melted and pulverized, 4 to 15% of titanium dioxide is added to produce the desired opacity. If cobalt is used in the enamel for the initial coating of metal articles, titanium may be added to the enamel batch in the form of rutile and it is said to neutralize the bluish color due to the cobalt.

Glass

Heat expansion of B_2O_3-, As_2O_3-, Pb-, and HPO_3-glasses and the dependence of their volumes upon solidification pressure. G. TAMMANN AND G. BANDEL. *Z. anorg. allgem. Chem.*, **192** [2], 139–44 (1930).—The p,T curves of many glasses show breaks which are displaced to higher temperatures as the pressure is increased. At the temperature of loss of brittleness, the expansion of glasses shows a decided increase. The evaluation of these p,T curves and of the breaks as they are related to some of the other physical properties of glasses are discussed. For B_2O_3-glasses the volume changes with the pressure and the temperature in a reversible manner. The break in the p,T curve occurs at 248° while the temperature at which the glass becomes brittle is 245°. This break depends on the rate of heating and decreases as the rate of heating is decreased. The rate of heating in these experiments was 2° per minute. The relation of the temperature of the break to the pressure is given by the following formula:

$$T \text{ (of break)} = 247 + 0.02p - 3.10^{-6}p^2$$

If one cools the glass and then increases the pressure by 500 kg./sq. cm. above that of the cooling pressure, then on reheating the glass the volume of the glass decreases in the softening range; following this there is a sharp increase in pressure which occurs at a higher temperature than when the glass is heated under normal pressures. On cooling the glass at this increased pressure it has a smaller volume than before. The change in volume with pressure can be obtained for B_2O_3-glasses according to the following:

$$\Delta v = \Delta p \cdot g \cdot \frac{ds}{dp}$$

An As_2O_3-glass was obtained by melting octahedral As_2O_3. On cooling molten As_2O_3 it remains largely in the glassy state. There is a break in the p,T curve at 180°, corresponding to the softening point. There is an increase in the volume of the glass on melting as shown by the behavior of the pressure on heating and cooling. On heating As_2O_3-glass beyond the softening point crystallization takes place and melting follows. The temperature at which brittleness occurs increases with increasing pressure. In As_2O_3-glass the volume decreases with increasing pressure under which it solidifies. Similar studies were made on lead glass. It also showed a decrease in specific volume with an increase of pressure under which it solidifies. Under a pressure of 2000 kg./sq.cm. the volume of lead glass is 0.60 to 0.70% smaller than when it solidifies at 100 kg./sq. cm. Metaphosphoric glasses have a water content of 7 to 12%. With decreasing water content the temperature of loss of brittleness increases. The break on the p,T curve depends on the pressure. For a glass with a water content of 12.4% it is given by the relation: $t = 33.5 + 0.0062p$, and for a glass with a water content of 9.9%, $t = 85.5 + 0.0053p$. The specific volume of these glasses decreases with increasing pressure of solidification, but the percentage volume change is only a third of that observed in B_2O_3-glasses. It decreases with a decrease of the water content of the glass.

L.T.B.

Anomalous phenomena in glass near its softening point. O. K. BOTVINKIN. *Ceramics & Glass*, **6** [9], 431–34 (1930).—B. reviews the existing literature on anomalous phenomena in glass near its softening point and describes his investigations. The re-

sults are as follows: (1) At certain temperatures lying below the softening point of glass, an anomalous change in the coefficient of cubic expansion of glass was observed; this interval coincides with the corresponding intervals for specific heat and viscosity. (2) Three transition points were found for all glasses, which disagrees with the investigations of M. O. Samsoen and others who found only two. M.V.K.

Influence of moisture in sand on mixing of the batch. I. I. KITAIGORODSKY AND I. A. SCHKOLNIKOFF. *Ceramics & Glass*, **6** [9], 415–19 (1930).—The tests gave the following results: (1) A minimum moisture of 0.2 to 1.3%, depending on the sand, greatly increases the homogeneity of the batch. (2) The maximum moisture content of sand to obtain a homogeneous batch is from 3 to 5%, depending on the sand. (3) The drier the other components the more homogeneous is the batch. (4) The homogeneity of the batch increases with the decrease in the grain size. (5) Sudden shaking causes a separating out of the constituents of the batch. (6) When moist sand is used, the tendency of constituents to separate out is considerably lessened since a mechanically-solid cohesion of the constituents of the batch exists. (7) Owing to a mechanically-solid cohesion of the sand particles with the alkali particles, the dust from the batch which lowers the durability of tank blocks and kilns is greatly diminished. M.V.K.

Effect of feldspar in glass. E. W. KOENIG. *Ceram. Age*, **16** [3], 150–52 (1930); for abstract see *Ceram. Abs.*, **10** [1], 24 (1931). A.E.R.W.

Determining the limiting temperature for cooling of bottles. A. I. SHILIN. *Sprechsaal*, **63** [47], 893–99 (1930).—Researches were made on (1) temperature of glass drops falling from the feeder on the form of the Lynch machine and of the flasks at the moment of passing from one end of the molding table to the other end; (2) temperature of bottles on leaving the Lynch machine; (3) decrease of temperature during forwarding on the conveyer; (4) determining the cooling curves of the bottle in factory operation; and (5) cooling of bottles (to different temperatures) before the cooling process, after which the degree of the release from tensions in the Simplex leer is to be determined. The results are as follows: (1) The temperature measurements, obtained with an optical pyrometer, of the bottles on leaving the Lynch machines coincide satisfactorily with the data of the cooling curves. (2) The temperature decrease of the bottle during working up on the fore-table amounts to an average of 12° per second for the bottom and 23° for the upper part; at the end of the table it is smaller, about 10° for the bottom. (3) The actual temperature decrease on the conveyer does not exceed 2° per second. (4) The temperature of the Lynch bottle at the entry into the leer is considerably higher than at the beginning of cooling. (5) If the conveyer is supplied with a heat-insulating cover, the decrease of temperature is lowered during the transfer of the bottle; in this way heat is saved but the conveyer is less accessible. (6) The temperature of bottles entering the leer is considerably different from the critical cooling temperature (400°); this makes possible a longer stay on the conveyer if required. (7) On entering the leer, the bottles have a high temperature and with this a proportionately high supply of heat. This would seem to make the heating of the outlet of the leer unnecessary. For cooling Lynch bottles, the Hartford method seems to be especially appropriate as it shows a series of advantages over the Simplex leer. M.V.K.

Making glass tubing. ANON. *Nat. Glass Budget*, **46** [34], 20 (1930).—An interesting phase of glass manufacture is that of drawing glass tubing, processes for which have been greatly improved. The original method was a hand process and consisted of blowing while the hollow cylinder was pulled out and cooled. Today, however, machines operate continuously, drawing the molten glass from the furnace, cooling it at a distant point, and cutting at predetermined lengths. A tank furnace supplies a steady stream of molten glass which is kept very hot by glass blowpipes. The glass forms a tube over a hollow mandrel by the aid of air which is forced through it. E.P.R.

Instruments for measuring refractive index of optical glass. ANON. Bur. Stand., *Tech. News Bull.*, No. 164, p. 118 (1930).—A 60° prism with edges measuring $^{3}/_{8}$ in. in length is sufficiently large for use with the most accurate apparatus now available. Large telescopes and special methods for correctly orienting the prism are unnecessary in the most accurate measurements. Small prisms may be used with confidence when testing optical glass for those small but harmful variations in optical density.

R.A.H.

Level gage for molten glass. F. W. MOWREY. *Chem. Met. Eng.*, **37** [12], 676 (1930).—Glass level in furnaces melting glass for the cylinder-drawing process has ordinarily been obtained by dipping a heated iron rod, bent at right angles, into the glass and holding the rod level. The accuracy of this method is not great. A variation of $^{1}/_{8}$ in. in level for the Fourcault drawing process is sufficient to cause serious trouble. An apparatus consisting of a lever arm capable of being supported on an adjustable fulcrum attached to the furnace buckstays will give the glass level within less than $^{1}/_{10}$ inch.

G.R.S.

New vacuum O'Neill machine. FRANK RUDOLPH PESSERL. *Sprechsaal*, **63** [50], 956 (1930).—P. describes the new vacuum O'Neill machine used by the Canning Town Glass Works, England. Twenty-three and one-half milk bottles of satisfactory quality and having a $^{3}/_{4}$-liter capacity are manufactured per minute. Although the weight of the machine is 11 T., it is manipulated by hand. A 3.5-h.p. motor drives it.

M.V.K.

Solarization and rejuvenation of window glass. ANON. Bur. Stand., *Tech. News Bull.*, No. 164, p. 118 (1930).—The rejuvenation of special window glasses in ultraviolet transmission may be accomplished by exposure of the glass to sunshine filtered through a blue-green glass that is opaqued to wave lengths shorter than 340 millimicrons, after solarization by exposure to full sunlight. Since solar rays of wave lengths shorter than about 305 $m\mu$ are absent in winter sunlight, it may be expected that the solarization caused in summer sunlight will be partly rejuvenated by exposure to winter sunlight. Data have been obtained which show that the possibility of recovery in transmission during winter will be of no use in sales promotion because the wave lengths at which this increase in transmission may occur are absent in winter sunlight.

R.A.H.

Cerium glass. GUY C. RIDDELL AND DONALD M. LIDDELL. *Mining & Met.*, **12** [289], 45 (1931).—The use of cerium for glassmaking shows an increase. The cerium salts are effective in cutting out ultra-violet rays, while giving little color to the glass. Neodymium and praseodymium have a high absorption for both infra-red and ultraviolet rays. Various combinations of these elements can be used to give all shades from a neutral gray to light ruby, grayish-blue, or brown-green. Borax for use in the glass industry shows the only enlarged tonnage use for the material that was evident in 1930.

E.J.V.

Coloring glass with coal and sulphides. A. X. BORK. *Ceramics & Glass*, **6** [9], 435–37 (1930).—The results of investigations showed that pure coal does not color glass either yellow or orange (brown), but that these colors and black generally depend on the formation of iron sulphide.

M.V.K.

Glass wool for storage-battery plates. ANON. *Sci. Amer.*, **143** [6], 478 (1930); *Ceram. Ind.*, **15** [6], 597–602 (1930).—The only plant producing glass wool in the U.S. is located in Millville, N. J. Fundamentally, the process of manufacturing glass wool is simply that of heating a glass rod to the softening point and then drawing it out into a fine thread. The glass rod is slowly rotated in a gas flame till the end is soft. An operator then touches this heated end with a cold rod and draws out a fine thread which is attached to the top of a large rotating wheel. The glass remains unbroken and

is wound on the wheel. Within about 3000 sq. ft. of floor space 500 lb. of glass wool are produced daily. The glass wool is stripped from the wheel and either shipped in hanks or fabricated into insulating plates within the plant. G.R.S.

Robert Hooke. J. R. MORGAN. *Sci. Progress*, **25**, 281–94 (1930).—Hooke (1635–1703) was the discoverer of the law *Ut tensio sic vis*. H.H.S.

Manufacture of glass. H. S. WILLIAMS-THOMAS. *Pottery Gaz.*, **56** [643], 100–102 (1931).—After a general discussion of the history of glass and its uses, the history of Stourbridge glassmaking is discussed. Methods of manufacturing table glass are described, starting with the furnaces, glass pots, materials, and procedure. The work of the craftsman and his tools is taken up, the making of a flower vase being described in detail. Both the cutting and engraving methods of decorating glass are described briefly. E.J.V.

Use of nonshatterable glass. ANON. *Amer. Glass Rev.*, **50** [13], 28 (1930); *Nat. Glass Budget*, **46** [36], 17 (1931).—Starting manufacture in the U.S. four years ago with only one use, in automobile windshields and windows, nonshatterable glass now fills nearly 100 different purposes, according to an analysis by the Triplex Safety Glass Co. of North America. Extending its use as a nonshatterable glass into the bullet-proof field, it has been utilized in submarines, naval vessels, airplanes, etc. Many additional fields have been opened for it with the development of the decorative laminated glass having great variety in both color and design. The nonshatterable feature is found to have equal value with the novel decorative features of the glass. E.P.R.

Glass dish used for diagnosis of lockjaw cases. ANON. *Amer. Glass Rev.*, **50** [12], 19 (1930). E.P.R.

Structural glass. ANON. *Ceram. Ind.*, **15** [6], 566–68 (1930).—The use of glass for structural members dates from the Paris Exhibition of 1900. Recent interest in structural glass has been increased by the recognized importance of proper illumination of all parts of a structure, by the advertising value of glass buildings to passers-by and by the marketing of structural glass in standard shapes. Prisms for sidewalks, floors, and roof lights; tile for windows, walls, and partitions; hollow block for walls and partitions; vacuum block for windows, walls, and partitions for insulating purposes; solid brick for walls and partitions; are all of standard dimensions. A 90% vacuum is obtained in the vacuum block. All shapes can be obtained in plain or ornamental finish, and glass brick may be wired, or in large lots, colored. Architectural experts place the cost of glass block and prism construction as ranging from $2.30 per sq. ft. upward, installed. W.W.M.

Windowless buildings. ANON. *Ceram. Ind.*, **15** [6], 568 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1039 (1930) and **10** [2], 154 (1931). W.W.M.

Glass industry activities in 1930 reviewed. ANON. *Amer. Glass Rev.*, **50** [14], 27–37 (1931).—Happenings of interest and importance in the glass industry during the year 1930, as chronicled each week in the *American Glass Review*, are summarized. E.P.R.

Glass improvement in Germany. ANON. *Times Eng. Supp.*, **27**, 134 (1930).—Addition of 4% borax to the mixing for the manufacture of ordinary glass has speeded up manufacture by 33%, and has lessened corrosion of pots by the lower temperature necessary. H.H.S.

BOOK

Glass. F. H. ZSCHACKE. Reviewed in *Chem. News*, **141** [3682], 302 (1930); for abstract see *Ceram. Abs.*, **10** [1], 81 (1931). G.R.S.

PATENTS

Conveyer for furnace. RALF S. COCHRAN. U. S. 1,784,812, Dec. 16, 1930. In

combination, a furnace chamber having work-entering and discharging openings at opposite ends, a conveyer of the work-lifting and translating type in line with the openings, the conveyer being positioned above the floor of the chamber, and means extending upwardly through the furnace side walls for supporting the movable part of the conveyer.

Preparing composite glass for sealing. JAMES H. SHERTS. U. S. 1,785,099, Dec. 16, 1930. The process of removing the periphery of the reënforcing sheet lying between a pair of glass sheets in a composite plate which consists in submerging the edges of the plate in a corrosive liquid which will react with the material of the reënforcing sheet but which will not react with the glass, and leaving the edges of the plate in the liquid until the edges of the reënforcing sheet have been removed to a point inside the edges of the glass sheet.

Gathering glass. KARL E. PEILER. U. S. 1,785,209, Dec. 16, 1930. A split suction gathering receptacle for glassworking, comprising coöperating longitudinal receptacle halves, a separate one-piece annular severing member adapted to be moved into coöperative relation with the lower end of the receptacle and having an opening therein adapted to form a continuation of the receptacle cavity, the receptacle and the severing member being adapted to be separated by a substantially-vertical bodily movement of one of them with respect to the other, and a reciprocable shearing member adapted to move across the bottom surface of the annular member in synchronism with the movements of the receptacle while the annular member is in coöperative relation with the receptacle.

Annealing materials. CHARLES B. KINGSLEY. U. S. 1,785,264, Dec. 16, 1930. (1) The method of annealing a continuously-formed sheet of glass, comprising advancing the sheet of glass through an annealing chamber of fixed cross-section and controlling the rate of cooling of the sheet of glass as it passes through the chamber by interposing between the upper surface of the sheet and the upper wall of the chamber a heat-absorbing and heat-retaining element without restricting the cross-sectional area of the chamber. (2) In an apparatus for annealing a continuously-formed sheet of glass, the combination comprising an open-ended treating chamber of fixed cross-section, means for conveying a sheet of glass through the chamber, and a heat-absorbing and heat-retaining curtain disposed immediately above the sheet of glass and away from the walls of the open-ended chamber.

Cutting sheet glass. CLIFFORD A. ROWLEY. U. S. 1,785,496, Dec. 16, 1930. An apparatus for transversely scoring a moving sheet of glass, comprising a carriage movable parallel with the movement of the sheet and including a guide bar for a scoring tool extending transversely of the sheet, and means connected to the carriage and engageable with the free end of the advancing sheet for moving the carriage with the sheet.

Drawing sheet glass. CLIFFORD A. ROWLEY AND JOSEPH A. REECE. U. S. 1,785,497, Dec. 16, 1930. In a sheet-glass apparatus, means for flowing glass continuously downward in sheet form, means for successively severing the sheet into sections, and for suspending the severed sections until set, a horizontal conveyer having a series of cleats, means for guiding the lower edge of each sheet as it is released from the suspending means into engagement with one of the cleats, and means for supporting the sheet at its upper edge until the sheet is laid upon the conveyer.

Leer feeder. IRVING SIMONIS. U. S. 1,785,534, Dec. 16, 1930. A leer feeder comprising, in combination, a ware conveyer, a plow arranged over the conveyer, means to reciprocate the plow longitudinally of the conveyer to move ware from the conveyer to one side thereof, and means to transversely incline the ware-supporting areas of the conveyer to facilitate removal of ware therefrom.

Forming thin-walled glass articles. THEODORE H. SLOAN. U. S. 1,785,535, Dec.

16, 1930. The method of forming a thin-walled glass article, comprising pressing molten glass to form a blank having a dome-shaped upper surface surrounded by a chilled flange, holding the blank horizontally by its chilled flange while its central portion sags and elongates downwardly therethrough, and blowing a finished article from the elongated blank.

Border seal for laminated glass. ROBERT W. HACKETT AND ARTHUR G. WORRALL. U. S. 1,785,696, Dec. 16, 1930. The herein described laminated glass, composed of two sheets of glass having an interposed sheet of celluloid or pyroxylin compound united into a unitary structure, the border edges of the glass sheets extending beyond the celluloid or pyroxylin sheet to provide a groove between the perimeters of the glass sheets, and the groove substantially filled with a sealing substance which comprises a powdered metallic base suspended in an adhering vehicle of a plastic character capable of being forced into the groove to be sealed.

Glass purification. GEORGE C. COX AND HENRY K. MCINTYRE. U. S. 1,785,888, Dec. 23, 1930. The process of purifying glass which comprises the maintaining of glass stock electrolyte at an optimum temperature by the generation of heat within the electrolyte, and the passing of direct current through the electrolyte, thereby depositing reduced metal at the cathode.

Manufacture of sheet glass. CLARENCE P. BYRNES. U. S. 1,786,892, Dec. 30, 1930. (1) In an apparatus for simultaneously producing a plurality of sheets of glass, a horizontal leer, a series of conveyers for carrying the separate sheets in parallel horizontal planes through the leer, and means positioned between each pair of conveyers for protecting the lower sheets from falling material. (2) The process of producing sheet glass, consisting in providing a mass of molten glass, skimming the molten glass by drawing the surface therefrom in sheet form, and then drawing a sheet from the skimmed glass.

Bottle-blowing machine. HANS HILLMANN. U. S. 1,787,312, Dec. 30, 1930. In a glassblowing machine of the class described, a rotary mold support, a glass tank associated with the support, a vertically-adjustable carriage on the rotary support, a preliminary mold mounted on the carriage, a finishing mold adjustably mounted on the rotary support, a neck mold adapted to coöperate with the preliminary mold in one position and with the finishing mold in another position, actuating means for moving the neck mold to the respective positions, cam means controlled from the preliminary-mold carriage to effect the coöperation of the neck mold with the preliminary mold in the various positions of the latter, a stationary support, and means on the stationary support for operating the actuating means.

Laminated-glass article. MAURICE C. HEATON. U. S. 1,787,371, Dec. 30, 1930. A laminated-glass article comprising a plurality of narrow strips of glass arranged in contact so that their side edges will form the respective faces of a panel, a layer of cement arranged between groups of the strips and a backing of cement covering one edge of all of the strips of glass, the backing merging into the layers of cement whereby all the parts are locked together.

Producing sheet glass. OTTO C. MILLER. U. S. 1,787,391, Dec. 30, 1930. In sheet-glass apparatus, a receptacle containing a mass of molten glass, a pair of rolls disposed thereabove and arranged to create a sheet-forming pass, and means for rotating the rolls in a manner to advance glass upwardly and through the pass to roll the glass into a sheet of predetermined thickness, the sheet being deflected over one of the rolls, the peripheral speed of the roll over which the sheet is deflected being relatively less than the peripheral speed of the other roll, so that the outer surface of the sheet will move relatively faster than the inner surface of the sheet when the sheet is being deflected.

Forming glass articles. ALBERT C. WILCOX. U. S. 1,787,460, Jan. 6, 1931. Glass article-forming apparatus comprising a source of molten glass having glass-delivery means, rheostat-controlled electrical means for heating the delivery means, a two-part mold, one part of which constitutes a glass article-supporting element movable relatively to the glass-delivery means whereby a glass article supported thereon is adapted to be supplied with glass from the means, the other part of the mold being constituted by an element movable with respect to the first mold element when the latter is stationary to heat and shape a glass article supported by the first mold element, and rheostat-controlled electrical means for heating the second-mentioned mold element.

Making glass bowls. JOHN EMERSON. U. S. 1,787,619, Jan. 6, 1931. The method of producing glass globes from glass materials of different colors which consists in placing a measured quantity of molten unmolded glass within a mold cavity, uniting molten glass of another color with the measured quantity within the mold cavity so as to effect uniform displacement of the measured quantity over a part of the other material and to present a sharp, uniform line of demarcation along the surface between the materials within the mold cavity, and then forming the materials into a globe of desired shape.

Glassware-forming machine. JAMES W. LYNCH AND EDWARD G. BRIDGES. U. S. 1,787,635, Jan. 6, 1931. In a glassware-forming machine, a base, a plurality of mold carriers rotatably mounted upon the base, means for intermittently rotating the carrier, means for locking the carrier against rotation during periods of rest, a ware-removing mechanism mounted upon the base adjacent one portion of the carrier and including a vertical shaft, pneumatically-operated gripping means associated with the shaft adapted to grip the ware in the mold, an arm associated with the lower end of the shaft and extending beneath the carrier, pneumatically-operated means on the arm for periodically establishing a locking connection between the arm and the carrier, a conveyer, means for imparting to the conveyer a step-by-step movement, means controlled by the carrier-rotating means for operating the pneumatically-operated gripping means, means associated with the carrier-locking means for operating the locking means between the carrier and arm on the lower end of the shaft and conveyer actuating means, the order of actuation of the control devices being as follows: (1) the gripping members are actuated to grip and lift the ware in the mold, (2) the locking means are actuated to establish an operative connection between the carrier and the arm on the ware-removing shaft, (3) the carrier-rotating means are actuated to rotate the carrier and thereby remove the ware from the mold, (4) the gripping means are released to drop the ware, and (5) the operative connection between the arm and the carrier is broken to permit return of the arm to its normal position over the mold.

Delivering glass. ROY E. SWAIN. U. S. 1,788,037, Jan. 6, 1931. The method of preventing the formation of laps and seams in a body of molten glass delivered from a container to a mold, comprising flowing the glass in a laterally-unconfined stream from an orifice of the container upon and supported by the bottom of a mold, during the major portion of such flow maintaining the bottom of the mold at a distance from the orifice of not more than about three times the diameter of the orifice, and lowering the mold from the orifice to check the stream of glass prior to severing it.

Glassblowing machine. JAMES W. LYNCH AND EDWARD G. BRIDGES. U. S. 1,788,312, Jan. 6, 1931. In a glassblowing machine, the combination of a blank table and a blank mold carried thereby, a blow table at one side of and on the same level with the blank table, a blow mold upon the blow table, the tables being spaced apart horizontally and having their adjoining portions movable in opposite directions respectively, means for opening the blank mold at a predetermined position, means for suspending the blank when released from the blank mold at the same elevation at which it was held by the blank mold, means for positioning the blow mold about the suspended blank, and

means for releasing the blank from its supporting means. The blank-supporting means and blow mold being movable toward the predetermined position from opposite directions respectively, and means for adjustably timing the releasing of the blank-supporting means with relation to the positioning of the blow mold around the blank.

Drawing glass. P. A. FAVRE. Brit. 336,460, Dec. 3, 1930. Relates to a method of making tubes or rods of glass, etc., and consists in distributing the molten material around a stationary former by means of a movable receptacle, and in drawing a tube or rod of the material from the lower end of the former. The molten glass flows from a tank into an annular trough which is rotated continuously about its vertical axis.

Forming glass tubes. P. A. FAVRE. Brit. 337,540, Dec. 24, 1930. Relates to a method of forming glass tubes or rods, described in Brit. 300,646 (see *Ceram. Abs.*, **8** [4], 266 (1929)), in which cylindrical glass blanks are threaded on a mandrel having an enlarged lower end, and the blanks are heated until the glass melts and flows over the enlargement and is drawn away as a tube.

Fused silica. DEUTSCH-ENGLISCHE QUARZSCHMELZE GES. Brit. 336,493, Dec. 3, 1930. A method of molding an article of fused quartz consists in expanding a hollow blank of the material in a mold by means of compressed air and then completing the shaping by applying mechanical pressure. An insulator with a number of collars can be made in a mold which contains a number of movable parts. The method may be used for forming tubes with ribs or flanges.

Glass manufacture. A. BRANCART. Brit. 336,533, Dec. 10, 1930. To prevent friction between a newly-formed glass sheet and the receiving-plate which guides it onto a table, a cushion of gas is formed between the glass and the receiving plate. For this purpose, the guide is made hollow and its upper face is formed with a large number of perforations. Air or gas under pressure supplied to the interior of the plate escapes through the perforations and forms a cushion beneath the glass. If air is used, it is preferably damp in order that the cushion may be formed partly of steam. A combustible gas may be used, and it becomes ignited by the heat of the glass which is then submitted to fire polishing as it slides over the guide.

Rolling glass. C. LOCREILLE. Brit. 336,550, Dec. 10, 1930. A table for receiving or casting glass plates or sheets is made of a sandless concrete composed of fragments of porphyry and of a cement formed of a ground mixture of calcined lime, silica, and alumina, the porphyry fragments being distributed in several layers through the thickness of the table according to their size. The bottom layer contains the largest fragments of porphyry and is reinforced by transverse bars, longitudinal bars, and rings covered with wire netting. A second and a third layer contain smaller fragments of porphyry, and the top layer contains porphyry which has been pulverized. The reinforcing bars and rings are made of a metal having a low coefficient of expansion.

Grading abrasives. PILKINGTON BROS., LTD., F. B. WALDRON, AND J. H. GRIFFIN. Brit. 336,587, Dec. 10, 1930. Grading apparatus for use in continuous glass-grinding machines, whereby abrasive of appropriate grade may be supplied continuously to the various grinding stages, comprises a channel increasing in cross-section from the inlet to the overflow, and has submerged partitions forming tanks for the different grades of abrasive and from which the abrasive is discharged, the portions of the channel where the velocity is high being formed in a tank of greater cross-sectional area than the channel.

Grading abrasives. PILKINGTON BROS., LTD., F. B. WALDRON, AND J. H. GRIFFIN. Brit. 336,588, Dec. 10, 1930. In apparatus for grading abrasives for use in continuous glass-grinding machines, the rate of flow of abrasive-laden water through the apparatus is controlled at different stages of the grading by automatically discharging excess water at intervals along the grading tanks. The invention is described in connection with

the apparatus in the preceding patent and consists in the provision, immediately before each weir, of a trough with a discharge pipe fixed at such a level above the weir as will give the desired head and flow of water over the weir.

Laminated glass. F. B. DEHN. Brit. 336,732, Dec. 10, 1930. Laminated glass is made by spraying a sheet of nonbrittle plastic material with a bonding medium, which may consist of a mixture of dibutyl phthalate and a polyglycol derivative, the sheet being then placed between coated glass plates and united thereto by heat and pressure.

Gathering glass. J. MONCRIEFF, LTD., AND A. F. MCNISH. Brit. 336,883, Dec. 10, 1930. A device particularly intended for supplying molten glass to a suction-gathering machine comprises a U-shaped channel or forehearth projecting from the front of a tank furnace and fitted with mechanism for circulating the glass, and a cover for the forehearth which is provided with a small aperture to allow access to a limited area of the glass, so that only this small surface of the glass at the gathering point is subjected to the chilling action of the air.

Generating oval forms. E. LAFFINEUR AND L. COLLIN. Brit. 336,919, Dec. 17, 1930. A device for forming ovals such as an ellipsograph, or a machine for tracing, cutting, molding, or plastering oval frames, or for bevel grinding the edges of oval glass plates.

Rolling glass. Y. BRANCART. Brit. 336,921, Dec. 17, 1930. Method of producing glass plates or sheets by forming them, or treating them immediately after formation, with a rough roller. The impressions formed on the plates by the rough roller disappear at once and leave the plates free from undulations. The present invention consists in rotating the rough roller at a slightly higher speed than if it were rolling on the plate, so that the glass is driven backward slightly toward the beginning of the plate.

Rolling glass. Y. BRANCART. Brit. 336,924, Dec. 17, 1930. Relates to the method described in the parent Specification of preventing undulations in rolled-glass plates by forming shallow impressions on the upper surface of the plates at the time of rolling. According to the invention, the plates are rolled by one or more smooth rollers, immediately after formation, in order to ensure that the impressions formed on the upper surface of the sheet disappear before the glass has become set.

Fused silica; windows. BRITISH THOMSON-HOUSTON CO., LTD. Brit. 336,923, Dec. 17, 1930. Flat sheets of fused silica which are suitable for window panes are made by fusing fragments of crystalline silica in a vacuum, allowing the silica while plastic to assume by gravity the form of a flat sheet, and then causing the silica to harden under gaseous pressure. The fusion of the silica is carried out in an electric furnace, similar to that described in Brit. 240,489.

Forming hollow glass. ALADDIN INDUSTRIES, LTD. Brit. 337,431, Dec. 24, 1930. A method of producing a vacuum flask consists in assembling two blanks, each having a closed bottom, one within the other, heating the free end of the outer blank until it is plastic, rotating the blanks and applying pressure to the softened glass to form a neck, and then applying pressure to the adjacent edges of the two blanks to bring them into contact so that they weld and form a rim at the mouth of the flask.

Heating safety glass assemblies, etc. DU PONT VISCOLOID CO. Brit. 337,547, Dec. 24, 1930. In a heating apparatus particularly for uniting laminated glass assemblies by subjecting them to heat and pressure, one or more assemblies are suspended vertically from the removable top of a fluid container. The container may be divided into quadrants by vertical partitions extending between inner and outer walls and the quadrants are further subdivided by partitions to form compartments adapted to contain a number of bags each enclosing a glass assembly. Each quadrant is provided with a liquid supply pipe and a discharge pipe, and a vent pipe is connected to each quadrant to permit the escape of air when filling up. The bags are preferably exhausted

of air and are suspended from hooks on the lid of the chamber. The lid is then placed in position and the container filled with water which is then circulated by means of a pump, a pressure of 150 lb. per square inch at a temperature of 250°F being usually employed for about 20 min. Three covers may be provided, one being in the working position while the others have bags attached thereto or detached therefrom. The bag containing a glass assembly may consist of a rubber body fitted with metal binding and a valve for connection with the vacuum pump.

Heavy Clay Products

Scum and efflorescence on brick and masonry. ANON. *Tonind.-Ztg.*, **54** [95], 1482–83; [97], 1510–11; [100], 1554–55 (1930).—The reasons for the appearance of efflorescence and scum on brick can be ascribed to the soluble salts in raw clay and to soluble salts formed during drying and firing. This formation may be prevented by (1) eliminating sulphur dioxide from the drying installations; (2) maintaining highest possible temperatures in the drying installations; (3) rapid circulation of air; and (4) keeping the moisture content as low as possible. The formation of salts during firing and their decomposition at higher temperatures can be fixed by the following factors; (1) draft strength; (2) velocity of reaching the finishing firing; (3) concentration of sulphur dioxide in the atmosphere; (4 and 5) temperature at which the kiln atmosphere is oxidized or reduced; (6) temperature of finishing firing; (7) time of finishing firing and (8) content of substances convertible into sulphates in clay. Investigations of the action of the sulphur content in combustibles showed (1) increased sulphur dioxide content of the combustible increases the quantity of sulphate formed in clays with a uniform lime content. The amount of sulphur in coal is therefore an important factor. With a small sulphur content, the quantity of sulphate formed is so small that it can hardly have an injurious effect. (2) The quantity of sulphates formed from coal with uniform sulphur dioxide content increases with increasing lime content of clays: further proof of the injurious influence of lime in clays. (3) The temperature interval most favorable for the absorption of sulphurous acid from the combustion gases and the formation of sulphates in the ware lies between 400° and 500°. In industry, therefore, the temperature between 300° and 600° must be passed through as rapidly as possible. (4) From 750° and up, the ware ceases to absorb sulphur dioxide from flue gases. Coals containing sulphur can therefore be used without damage for the finishing firing, but not for drying and smoking. It was also found that the prevention of sulphate formation needs less energy than its decomposition. M.V.K.

Causes and remedies of efflorescence. W. ANGUS MCINTYRE. *Brick Clay Rec.*, **77** [13], 732–36 (1930).—In discussing the coatings caused on clay products by the soluble salts in the clay, the word "scum" should be restricted to describing the coatings which may appear on brick during their manufacture, either in the drier or in the kiln, and should not be used to describe deposits which occur on the brick after they have left the kiln. The latter phenomenon, the crystallization of soluble salts on the surface of the brick after they have been exposed to the atmosphere for varying periods, is a very well-known one to which the term "efflorescence" is commonly applied. In addition to this outward visible growth, however, salts may crystallize in the pores of the material, remaining unsuspected for long periods, and these may give rise to serious damage. For salts which occur in this way, the word "cryptoflorescence" is used, while the general phenomenon of the crystallization of salts in the pores, or on the surface of the material, is known by the term "florescence." It can be said quite definitely that the dominant constituent of the great bulk of florescence is sodium sulphate. Knowing the composition of florescences, the causes of florescence can be considered. The prime

cause is undoubtedly water which enters the brick in some way, carrying or dissolving the salts, and depositing them in or on the brick. A careful consideration will show that there are five possible natural origins for these salts: (1) salts derived from the mortar, backing, etc., in the wall; (2) salts derived from ground waters which have risen in the brickwork; (3) salts present as such in atmospheric dust; (4) salts which were originally present in the brick; and (5) salts arising from the decomposition of the material. Each of these origins is discussed, as are also the following: (*a*) movements of solutions in brickwork; (*b*) disintegrating action of salts; (*c*) action of salts; (*d*) physical effects of salts; (*e*) failure of cement and plaster; and (*f*) some causes beyond control. See also *Ceram. Abs.*, **9** [8], 639 (1930). E.J.V.

Manufacture of dry-pressed brick. ANON. *Tonind.-Ztg.*, **54** [94], 1469–70 (1930).—Slate clays and some ferriferous loams are especially adapted for dry pressing. It is important that the clays have a small water content averaging 6 to 8%. The clays are very carefully prepared. The air is removed during pressing as it causes cracks not noticeable until the brick is fired. M.V.K.

Manufacture of dry-pressed brick. ANON. *Tonind.-Ztg.*, **54** [98], 1523 (1930).—Plastic clays can be used with success for the manufacture of dry-pressed brick if the clays have a uniform moisture content when ready for pressing. This is obtained by storing the clay in a closed space for several weeks or months which is necessary before they can be worked. It is recommended also to dry the dry-pressed brick before firing. M.V.K.

Hollow brick. ANON. *Tonind.-Ztg.*, **54** [98], 1527–28 (1930).—A hollow brick with closed surfaces, a "cell brick," containing from 102 to 120 holes of 10-mm. diameter is described. The holes are not completely air-tight so that drying and firing do not affect the brick. M.V.K.

Adhesive construction in brickwork. EUGENE S. POWERS. *Clay-Worker*, **94** [6], 381–83 (1930).—In adhesive construction the structure depends entirely for its strength on the adhesion of the brick which are laid overlapping one another and cemented together with mortar. In the adhesive system of construction it is possible to make the brick masonry as truly monolithic as concrete, and with reënforcing placed as in concrete beams and slabs, to serve in their stead. The adhesive principle has been used for years, but necessarily to a limited extent due to lack of the following information: (1) adhesive properties of various kinds of mortar to brick of various textures and porosities; (2) shear values of these mortars parallel to the joints; (3) determination of the best mortar to use with any particular type of brick and the bond that such a mortar would have on the steel embedded in the brickwork as laid by the bricklayer; and (4) properties of finished brickwork of various types, particularly their modulus of rupture. Illustrated. E.J.V.

Porous clay balls as aggregate for lightweight product. KNOX HARDING. *Brick Clay Rec.*, **77** [13], 727 (1930); *Popular Sci.*, **118** [2], 34 (1931).—A new inflated lightweight fired clay product known as Vesicullite is manufactured in the form of cellular porous inflated clay balls of aggregate size, with a hard, solid, outer shell of fire clay. It is said that it can be made into brick that weigh one-fourth to one-seventh as much as the ordinary product, using 60 to 70% less clay. After pugging the clay it is exuded through a die in 1000 strips, and automatically it is cut 17 times a second to make 17,000 billets which are rolled in globular balls and coated with fire clay in a simplified continuous chewing gum ball rolling and coating machine. The firing is done in a large rotary kiln. Illustrated. E.J.V.

Salt glazes. ANON. *Tonina.-Ztg.*, **54** [96], 1497 (1930).—The ingredients of ceramic bodies such as silica, alumina, iron oxide, fired kaolin, and feldspar react with the vapors of common salt and water. Temperatures required for glazing depend on

the body composition, the minimum being Seger cone 3*a* (1140°). Highly porous bodies are not suitable for glazing. Reduced firing promotes the formation of salt glazes in the presence of iron oxide. The tests of E. Berl and H. Staundinger on the cleavage of sodium chloride by steam in the presence of silicic acid are discussed and their importance is pointed out as the processes studied are similar to those taking place during the formation of salt glazes. M.V.K.

Glazing brick. ANON. *Lerindustrien*, **5**, pp. 24–27 (1930); *Tonind.-Ztg.*, **54** [99], 1548 (1930).—Practical directions are given for the composition of glazes for brick with special reference to clays from Denmark. M.V.K.

Recent improvements in methods of brickmaking. III. ALFRED B. SEARLE. *Jour. Roy. Soc. Arts*, **78**, 1042–52 (1930); for Parts I and II see *Ceram. Abs.*, **10** [1], 35 (1931). (*C.A.*)

Discussion of "Stiff-mud die troubles." R. H. ELLIS-ANWYL. *Bull. Amer. Ceram. Soc.*, **10** [1], 9 (1931).—A brief comment on experience with stiff-mud die troubles is given. E.J.V.

Methods used in testing masonry specimens for bending, tension, and shear. NORMAN W. KELCH. *Jour. Amer. Ceram. Soc.*, **14** [2], 125–32 (1931).—Twenty-four walls, $4^1/_2$ ft. wide, $5^1/_2$ ft. high, some 8 in. and some 12 in. thick, were tested for bending after aging sixty days and six months, respectively. It was shown that aging of lime mortar is essential. Failures in shearing stress were also due to immature mortar. Brick masonry withstands earthquake shocks when mortar is matured by aging. An outline of the more extensive tests is given. See also *Ceram. Abs.*, **9** [3], 184 (1930).

Strength tests on roofing tile. NORMAN W. KELCH. *Jour. Amer. Ceram. Soc.*, **14** [2], 133–38 (1931).—Conditions and methods of making simulative tests on roofing tile are developed. Rupture of the whole tile on standard edges seems to be the most reliable test and is, therefore, recommended. Specifications are adopted covering (1) absorption (15%), (2) soundness, and (3) strength.

Brick forms for concrete. L. B. LENT. *Brick Clay Rec.*, **77** [13], 720–22 (1930).—Brickwork has been used as a "form" for concrete masonry for many years, but its advantages seem not to have been generally recognized, and its use for this purpose not greatly extended. Advantages of this type of construction are pointed out, using typical installations as examples to bring out the various points mentioned in the discussion. Illustrated. E.J.V.

Certification of brick. ANON. Bur. Stand., *Tech. News Bull.*, No. 164, pp. 121–22 (1930).—About 35% of the 1200 known common-clay brick manufacturers and 75% of the 48 known manufacturers of sand-lime brick have expressed their desire to be listed as sources of supply of brick guaranteed to comply with Federal Specifications, Nos. 504 and 505. Officers of the clay and sand-lime brick associations are coöperating with the Bureau in an attempt to have the whole membership of these associations represented on the Bureau's willing-to-certify lists. R.A.H.

Fernleaf texture and weathered mat face brick. ANON. *Clay-Worker*, **94** [6], 384–87 (1930).—A detailed description of the plant of the Cambria Clay Products Co., Johnstown, Pa., is given. This plant, with a capacity of 40,000 brick per day, produces the Fernleaf texture face brick, Cambria ladle brick, and weathered mat texture, in all shades, both smooth and rough texture. Illustrated. E.J.V.

Richards Brick Co. ANON. *Brick Clay Rec.*, **77** [13], 697–704 (1930).—The new stiff-mud unit of the Richards Brick Co., Edwardsville, Ill., is a trim, neat, and efficient job of engineering. The various problems encountered in the construction are enumerated and a detailed description of the layout and equipment of the unit is given. Illustrated. E.J.V.

Feifel hollow brick. ANON. *Tonind.-Ztg.*, **54** [101], 1572–73 (1930).—The new

apparatus of the firm, Wanner, is constructed to countersink, seal, and cut the brick in a single process. Five-sided brick are made by the same machine. M.V.K.

Heimstätter brick plant. G. BENFEY. *Tonind.-Ztg.*, **54** [94], 1470–72 (1930).—The brick plant of Heimstätter near Finow, Germany, is described. The plant manufactures yellow brick and face clinker. The brick are dried in two channel drying installations and are heated by condensed waste steam. Drying requires 18 to 20 hr. An annular and a tunnel kiln are used for firing, and have an output of about 100,000 brick; half of these brick are clinker having a resistance to pressure of 500 kg./sq.cm. M.V.K.

How to judge brickwork quality. L. B. LENT. *Bldg. Econ.*, **6** [11], 20–21 (1931).—Brickwork is judged by (1) quality of brick: Hard, well-fired brick are durable and resist weather. (2) Quality of mortar and mortar joints: Clean sand and mortar should be employed, and that quantity of cement to insure a dense, strong mortar. (3) Quality of workmanship: These details are usually regulated by local building codes. (4) Basement and foundation walls: Brick are excellent for basement and foundation walls. (5) Outer walls: Artistic treatment is referred to here. E.P.R.

Analysis of face-brick industry. FRANKLIN DICKEY. *Clay-Worker*, **94** [6], 390–92 (1930).—In making an analysis of the face-brick industry and the condition thereof, D. enumerates the reasons for volume restriction. (1) Face brick is not a vanishing product. (2) So far, no practical means have been developed for increasing the aggregate square footage of walls for which the product may be considered as a facing material. (3) Although face brick is attractive and cheap, the public will not consider purchasing it merely as a completed product among the many others. (4) The value of the material is generally but a small part of the total cost of the building project, and the profit spread is consequently narrow. (5) The freight burden it carries is excessive compared to the value of the product. The remedy for conditions is suggested as a lowering of production and raising of prices. E.J.V.

New masonry products. ANON. *Arch. & Bldg.*, **62** [10], 302 (1930).—Brikron is a new admixture which prevents efflorescence, leakage, crazing, cracking, and spalling of masonry mortar joints. E.P.R.

Airport drainage needs point to market for drain tile. H. E. COTTON. *Brick Clay Rec.*, **77** [13], 717–18 (1930).—C. advances some constructive suggestions with regard to the proper drainage of airports which makers of clay drain tile and sewer pipe should find of value. Some of these are based on results obtained in such work at New Orleans. E.J.V.

Chicago architects and clay products. ANON. *Brick Clay Rec.*, **77** [14], 774–75 (1930).—With the architects seeking new building materials and the clay products manufacturers beginning to respect this demand, it is natural that prominent architects are beginning to recognize this willingness. While opinions on the rendering of a building in a colorful motif vary, the various architects interviewed agreed that as a building material for homes, brick is foremost. Illustrated. E.J.V.

Chrysler Building, New York. EUGENE CLUTE. *Arch. Forum* [Part 1], **53** [4], 403–406 (1930).—The Chrysler Bldg. overtops every other completed structure at the present time. It stands 69 stories above the street and 1050 ft. above the ground. The lowest of the flanking masses are great squarish blocks. The windows are evenly spaced in gridiron formation and the facing of the walls is of light gray brick with inset strips of white marble. On the tower, horizontal banding is produced by grouping the windows horizontally through the use of courses of black brick. This brick being glazed catches the same high-lights as do the glazed window openings. At the corners the courses of black brick are carried around leaving rectangles of white brick that give an effect very like that of quoining. E.P.R.

Adaptability of brick. ANON. *Bldg. Econ.*, **6** [12], 1–2, 10–19 (1931).—The adaptability of brick to any type of architectural design is exemplified in the variety of buildings in which it has been used in Maryland. E.P.R.

Use of brick in sea walls. ANON. *Bldg. Econ.*, **6** [11], 17 (1931).—A brick sea wall, constructed in Seattle, was supported by pilasters. Its success indicates the strength and durability of brick for this type of construction. E.P.R.

Brick used at Ft. Humphreys. ANON. *Bldg. Econ.*, **6** [11], 7–9 (1931). E.P.R.

Skintled brickwork. ANON. *Bldg. Econ.*, **6** [11], 3 (1931).—In the houses shown in the article, samples of New England skintled brickwork clinkers are used in considerable numbers and with striking effect. E.P.R.

Band courses in English brickwork. G. K. GEERLING. *Architecture*, **62** [6], 343–46 (1930).—An analysis of the successful brick façades of houses, particularly in England, provides an interesting study in the effect produced by horizontal lines. The English have always appreciated the value of making the house appear as though it grew out of the ground, and in countless cases, have accomplished this solely by accenting the horizontal feeling. Illustrated with drawings and photographs. G.R.S.

Imperishable brick. ANON. *Tonind.-Ztg.*, **54** [99], 1546 (1930); for abstract see *Ceram. Abs.*, **10** [2], 94 (1931). M.V.K.

Use of brick in ancient Rome. ANON. *Bldg. Econ.*, **6** [11], 16 (1931).—Rome, more than any other old-world city, favored brick construction. E.P.R.

Brick of 2300 B.C. ANON. *Bldg. Econ.*, **6** [11], 22 (1931).—Something of the tremendous scale upon which the ancient kings of Ur made and used brick was disclosed by discoveries made by the Joint Expedition of the University of Pa. and the British Museum in Mesopotamia. E.P.R.

PATENTS

Preventing efflorescence in ceramics. ARTHUR HOUGH AND JOHN GEORGE HARRISON. U. S. 1,785,309, Dec. 16, 1930. The process of preventing efflorescence or scumming in ceramics which comprises adding barium silicate to the material from which the ceramics are made.

Building block. FRED SAYERS. U. S. 1,785,499, Dec. 16, 1930. (1) A building block having tongue and groove elements for interlocking in a wall construction, and gage elements for spacing the interlocked blocks in predetermined relation in the wall, the block having further mortar gages for measuring predetermined quantities of mortar requisite for the spacing predetermined by the gages. (2) A hollow building block having a longitudinal passage extending completely therethrough and having intermediate the ends of the block an annular rib extending inwardly into the longitudinal passage and forming an annular reënforcement about the passage for strengthening the intermediate hollow portion of the block between the ends of the same.

Making a conduit. LLEWELLYN M. CHRISTIE. U. S. 1,786,425, Dec. 30, 1930. A ceramic conduit section for electric installations comprising a unitary homogeneously-formed body portion and end flanges integral with the body portion and provided with means for connecting the section to adjacent sections.

Bricklaying machine. FRANK C. LAYER. U. S. 1,786,622, Dec. 30, 1930. In an improved bricklaying machine the combination of a framework, a second framework slidably mounted thereon and movable vertically with respect thereto, a carriage mounted for reciprocating movement on the second framework, an endless conveyer mounted in the second framework and associated with the carriage, and means for maintaining the upper reach of the endless conveyer stationary during the reciprocating movement of the carriage in one direction only.

Tunnel or conduit lining. JOHN F. O'ROURKE. U. S. 1,788,248, Jan. 6, 1931.

A tunnel or conduit lining comprising a plurality of aligned rings separated by grouting interstices, each ring being composed of a plurality of segmental blocks, and corrugated plates interposed between the ends of adjoining blocks in the same ring, determining a proper spacing therebetween and providing passages permitting the flow of grout therethrough, the plates having corrugations directed longitudinally of the lining.

Porous masses. J. Y. JOHNSON. Brit. 336,318, Dec. 3, 1930. Porous masses are made by incompletely decomposing silica or siliceous materials by means of alkali or alkaline salts and heating the resulting mixture of soluble silicates and undecomposed residue. Raising agents may be added before heating. Suitable initial materials are kieselguhr, rocks, and earths, *e.g.*, clays, flint, and geyserite, silica arising in the manufacture of superphosphate or of alumina, and siliceous residues from the decomposition of bauxite. Suitable decomposing agents are caustic alkalis, sodium carbonate, alkali metal aluminates, alkali waste liquors, etc. Examples of raising agents are substituted naphthalene sulphonic acids, soaps and saponinus, metals, *e.g.*, aluminium and magnesium, silicon or its alloys, silico fluorides, hydrofluosilicic acid, and salts, *e.g.*, the nitrate, sulphate, and chloride of aluminium. Numerous inorganic and organic filling materials are specified. In some cases, organic filling materials are eliminated by burning to increase the porosity. In order to strengthen the products, magnesia may be admixed, and the products afterwards treated with magnesium chloride, or the products may be coated with a layer of cement. The products may be porous brick, slabs, etc., for building purposes, granular or plate material for insulating against sound, heat, and electricity, filters, diaphragms, asborbents, etc., and fillers for rubber, lacquer, paper, etc. *E.g.* (1) 100 parts of Si material, obtained in the manufacture of alumina by treating fired clay with hydrochloric acid and consisting chiefly of hydrated silica, are heated with 200 parts of a 20% solution of caustic soda and thereby thickened to a solid mass. After the addition of further Si material, if desired, the mass is heated to about 300 to 500 °C until it swells to several times its original volume. The mass may then be exposed to higher temperatures for a short time. In a modification, the heating is stopped after a partial swelling, the mass crushed to powder when cold and then caused to swell again by heating after it has been made into a paste with water, or pressed together. (2) 100 parts of Si material and 200 parts of a 20% solution of caustic soda are heated for some time while stirring and concentrated to a thick paste. After cooling, the solid mass is granulated, and 100 parts are titrated with 15 parts of water and placed in an iron mold having an upper cover comprising a movable iron plate resting on the mass and capable of rising to the top edge of the mold but not higher. The mold is slowly heated, whereupon the material swells and raises the cover till it reaches its uppermost position. The pressure then exerted, on continued heating, causes a denser structure of the outer layers of the mass. (3) A ball-like foamy material for insulating and filling is made by heating grains of the mass produced by decomposing Si material with caustic soda as described in the preceding example, on metal plates or belts or in a revolving furnace. Other examples are described. The Provisional Specification also comprises more broadly the production of porous masses by heating mixtures of aqueous solutions of silicates and fillers, preferably siliceous. *E.g.*, 100 parts of a solution of water glass of sp. gr. 1.3 are mixed with 20 to 30 parts of quartz meal and heated. The quartz meal may be replaced by ground glass, slag, pumice, or other fillers.

Brick for chimneys, etc. W. J. VAN DER KRAGT. Brit. 336,469, Dec. 3, 1930. Brick for chimneys and flues are provided round the edge of the flue opening with an upstanding ridge or collar which fits into a corresponding shallower recess in the brick in the course above, so that mortar-receiving grooves are left when the blocks are assembled, while the flue opening is formed by closely abutting portions without mortar joints.

Molding hollow brick. K. MAUS. Brit. 337,115, Dec. 17, 1930. Hollow building blocks, closed on all sides, are made by extruding a tubular stream of clay, etc., dividing the stream into blanks of excessive length and then acting on the blanks by side plungers to close the open ends. A filler, preferably of combustible substance, may be inserted in the blank prior to closing. During extrusion through the nozzle a fluid mixture of pulverulent iron, oxide of iron, sodium, and potassium salts, or a solution of soda or of caustic alkali may be charged into the inner surface of the clay, etc., stream through radial holes. Glazing material may be similarly supplied. Two or more streams are extruded simultaneously. The filler may be a chemical, or a fuel, or a mixture of these and the chemicals may comprise sodium or potassium salts, iron salts, iron oxide, glass, or slag. The fuel may be sawdust or disintegrated and dry peat. After insertion of the filler, cup-ended hollow plungers working over the plungers are moved inward to effect preliminary closing of the blank ends. In a modification, blanks of double length may be formed and a central partition formed by plungers which scrape the interior surfaces. After filling, the ends are closed and the blank divided into two closed blocks by division across the central partition.

Molding brick. T. KOIDL AND F. GORLICH. Brit. 337,231, Dec. 17, 1930. A press for extruding a string of brick is provided with means for charging compressed air into the plastic mass prior to the mass reaching the extrusion nozzle, in order to produce porous brick.

Refractories

Kaolin as raw material for refractories. E. KÖHLER. *Trans. Ceram. Research Inst.* [U.S.S.R.], **25**, 44 pp. (1930).—The testing materials were prepared from 50% raw kaolin and 50% grog which was fired to 1200, 1350, and 1600°. The composition and properties of the materials used are tabulated. The samples prepared were fired to 1200, 1350, 1600, and 1750° and tested. The resistance of the samples to sudden temperature changes was determined by a method of K. The refractoriness of all kaolins corresponds to Seger cone 36. A special apparatus used for determining the deformation showed that by firing to high temperatures it is possible to prepare very resistant objects which show no deformation with 2 kg./sq. cm. pressure at temperatures over 1550°. The deformation curves of these fired kaolin masses are very similar to those of silica blocks. The irregular course of curves characteristic of kaolin disappears completely at sufficiently high firing temperatures. This can be explained by the extensive formation of mullite. The researches clearly showed that kaolin is a highly-valuable raw material for the refractory industry. For practical utilization of kaolin, a sufficiently high firing (about 1450 to 1500°) of the product must be taken into consideration. With this condition it is possible to manufacture highly-refractory kaolin blocks of the greatest resistance to deformation and chemical action. M.V.K.

Manufacture of refractory and acid-proof products free from grog. P. P. BUDNIKOFF, S. GICHAREVITSCH, AND I. G. SCHACHNOVITSCH. *Ber. deut. keram. Ges.*, **11** [5], 275–84 (1930); *Refrac. Jour.*, **6** [63], 112 (1930).—As most of the costs are due to the preparation of the raw materials, *e.g.*, firing the grog and drying the brick, the manufacture of the same products without grog is considered. Conclusions are as follows: (1) Refractory products, brick, etc., can be manufactured without grog by adding clay made lean by heating. (2) The manufacture can be mechanized entirely. For the dehydration of the clay, a drying drum can be used. (3) The drying is unnecessary. (4) It is unnecessary to have a complicated and expensive equipment for preparing mixtures. (5) The material cost of the products will be lower. See also *Ceram. Abs.*, **9** [9], 749 (1930). I.R.

Manufacture and testing of cristobalite and tridymite. A. ZWETSCH AND W. BUECKING. *Ber. deut. keram. Ges.*, **11** [5], 262–75 (1930).—Qualitative analysis of crystals with the help of X-rays is applicable to fired materials. The fired bodies are compared with the pure materials. The first necessity is to develop absolutely pure standard materials. A method was developed to change quartz into cristobalite or tridymite. The dilatometer method has been used. It was easier to develop cristobalite from the different materials than the tridymite. To develop tridymite, mineralizers had to be used. I.R.

Silesian magnesite. A. REIMERS. *Keramos*, **9** [23], 875–77 (1930).—R. describes the large deposits of magnesite in Silesia, Germany. This magnesite is of very high quality. It is white and almost pure, without iron and lime, and is used mostly for the preparation of xylolite which is a mixture of caustic fired magnesite, organic or inorganic filling materials, and coloring matter. Wood powder or micro-asbestos is used chiefly as filling material. The mixture is moistened with magnesium chloride solution and then pressed into plates. The main properties of these plates are elasticity, capability of holding heat, soundproofness, highest resistance to strain, dustproofness, and rapid and easy manufacture. Magnesite is also used in preparing refractories, artificial millstones, abrasives, and in chemical and pharmaceutical industries. M.V.K.

Determining refractoriness of clay. P. A. ZEMIATSCHENSKY AND F. A. ZENKOWITSCH. *Trans. Ceram. Research Inst.* [U.S.S.R.], **24**, 29 pp. (1930).—Clays which were pulverized, mixed into a paste, and molded into cones of a definite size, were fused by an apparatus consisting of a soldering pipe heated by a blasted alcohol flame. Knowing the diameter of the cone, it was easy to determine the melting temperature of the clay cones. In cases where the clay samples did not melt, melting agents were added to the paste, and according to the quantity added, it was possible to ascertain the melting temperature. The diameter of the cone must remain constant. Iron oxide and lime, which do not produce a eutectic, proved to be the most appropriate melting agents. Tables were compiled from which the melting temperature could be ascertained. Comparing the results of these tests for the refractoriness of clays, a difference of about 50° was found. Only 30 minutes are required for the tests. This method used in practice gave very satisfactory results. M.V.K.

Influence of atmosphere on load-bearing capacities of fire brick. S. C. H. SWALLOW. *Refrac. Jour.*, **6** [63], 85–94 (1930).—It has been shown that the softening temperatures of cones made from artificial mixtures of a Seger cone material with iron oxide added in various forms and amounts, were lower when the test was carried out in reducing gases such as hydrogen, methane, and carbon monoxide, and also in steam. The lowering of refractoriness was shown to be proportional to the iron content of the cones. It was found subsequently that cones ground from commercial fire brick did not suffer any pronounced reduction of refractoriness in this way although their iron contents were in some cases higher than those of the artificial mixtures. It was decided that the influence of atmosphere on commercial fire brick could be investigated better by some form of load test. Five fire brick representing samples from various parts of the country were chosen for experiments. The refractoriness, refractoriness under load of 50 lbs./sq. in., true and "apparent" porosities, and powder specific gravities of these materials, together with analyses supplied by the makers and notes regarding texture, etc., are given. The method of experiment consisted in raising the temperature of the furnace at approximately the standard rate of 10°C per minute to a predetermined temperature which was held constant throughout the test. The deformation (as scale divisions) was plotted against time under oxidizing conditions until the rate of deformation had become comparatively small. A reducing atmosphere was then applied and the deformation plotted for a further period. For temperature measurement, an optical pyrometer of the disap-

pearing-filament type was used. When using coal gas it was necessary to turn off the gas in order to read the temperature. In regard to steadiness of temperature it was found that the admission of coal gas tended to cause a slight rise of temperature due to (*a*) radiation of heat from the flame of the burning coal gas back into the furnace, and (*b*) loss of the cooling effect of unlimited supply of cold air. Reducing conditions were brought about by pouring coal gas into the furnace from the top. The gas need not be passed at a high rate as its flame burning around the top of the furnace prevents access of air to a large extent. Three further experiments were made with the object of finding out if it were possible for failure of a fire brick which would be stable under oxidizing conditions to be brought about by a reducing atmosphere alone. The load test curve for this showed that the brick ceased to expand just above 1200°C and a slight contraction occurred amounting to about 0.34%. Steam was then blown into the furnace through two tubes in much the same manner as the coal gas and it was found that the influence of steam on the load-bearing capacity of fire brick during the short time of these experiments appears to be quite negligible. A general equation for the relationship between amount of deformation (D) and time (T) at constant temperature and under constant load has been suggested by A. J. Dale. Where k and m are constants relative to the particular fire brick, temperature, and load employed, $D = kT^m$ from which the equation $\log D = m \log T \times \log k$ is derived. If this equation is valid, then the result of plotting $\log D$ against $\log T$ should be a straight line, the slope of which will be equal to m. Assuming that the equation also holds after the change to reducing conditions, it may be expected that deformation will proceed approximately according to the same law but will be represented by an equation bearing different constants, a short interval being allowed for complete reduction to take place. Since reduction can occur at any given time, depending on the will of the experimenter, the value of k in the above equations can have no special meaning in this connection. Any influence the atmosphere may have on the rate of subsidence will be apparent in the altered value of m. The dissociation of ferric oxide according to the equation $6Fe_2O_3 = 4Fe_3O_4 \times O_2$ has been the subject of investigation by R. B. Sosman and J. C. Hostetter, who showed that the composition of the oxides of iron in contact with oxygen is governed by two factors: (1) by the total or partial pressure of the oxygen and (2) by temperature.

E.P.R.

Refractories installations. ANON. *Brick Clay Rec.*, **77** [13], 709–13 (1930).—Ability of the refractory to resist numerous destructive actions varies with the type of furnace. The type of fuel is of major importance in the life of refractories. The corrosive action of slag on refractories is recognized but the fact that the strength of a brick is greatly reduced by penetration of slag is not generally recognized. The temperature gradient in the refractory is an important factor in slagging action. With refractories of high thermal conductivity the rate of heat loss through the body is sufficient to maintain a viscous slag at or near the contact, thus reducing slag penetration and corrosion. Low refractoriness or firing too high reduces resistance to slag action, due to diffusion of slag in the glassy portion of the body. The development of a vitreous and impervious layer of the body, without excess of glass, next to the slag contact reduces corrosion. Bodies of very high refractoriness, which do not vitrify at furnace temperatures, permit slag penetration and are more affected by slags than less refractory bodies. A high-alumina brick showed less resistance to high-lime slags than did fireclay brick, but a greater degree of resistance to slags of low-lime and high-iron contents. Increase of furnace temperature produces a marked increase in the erosion of refractories by coal ash. It has been found that for combinations of ash and refractory there are three ranges or conditions, as follows: (1) The lower temperature range, where the glassy constituents of the slag cannot dissolve the refractory because the slag is saturated with

solid material from the ash itself. This is a safe working range for the given combination. (2) A critical temperature range where most of the crystalline phases from the slag components have come into solution and the slag is mostly liquid. This represents the danger point at which the glass can just dissolve all of the available solid material in the slag. Any further rise in temperature will result in severe corrosion. (3) The upper temperature range where severe refractory corrosion begins, increasing rapidly with further increase in temperature. Tests on crushing strengths of brick which were saturated with slag and some which had similar treatment but no contact with slag revealed a great decrease in the strength of the former as compared with the latter. Some methods of overcoming some of the difficulties encountered with refractories in various settings are suggested. Illustrated. E.J.V.

Heat insulation with fired moler earth in firing installations. H. WINKELMANN. *Chem.-tech. Rund.*, **44**, p. 893 (1929); *Sprechsaal*, **63** [48], 918 (1930).—Insulating blocks used in firing installations do not possess the required solidity. Moler blocks, prepared from the moler earth of the island of Jütland, are an exception. Through admixtures of organic substances which volatilize during firing, the porosity of the blocks can be easily regulated. The most porous brick, marked HP I, which possesses the greatest insulating capacity, has the lowest mechanical solidity and is used only for pure insulating purposes. The brick HP II has a higher resistance to pressure and the block HP III is used when high requirements for resistance to pressure and temperature are desired. The properties of the three kinds of blocks are tabulated. M.V.K.

Sillimanite as material for crowns in electric steel furnaces. F. SOMMER. *Stahl Eisen*, **50** [48], 1676–77 (1930).—Fired sillimanite blocks have replaced the unfired sillimanite blocks in crowns in electric steel furnaces. A comparison of silica crowns with sillimanite crowns shows that an average of 300 T. of steel could be fused with a sillimanite crown while silica crowns could fuse only an average of 130 T. Thus the durability is in the proportion of 2.3 to 1. See also *Ceram. Abs.*, **9** [9], 746 (1930). M.V.K.

Observations on the behavior of refractory materials in continuous vertical retorts. A. T. GREEN. *Gas Jour.*, **192** [3524], 720–25 (1930).—The systematic study of the condition of retorts after their effective life forms a source of valuable data. Information should be obtained concerning (1) the internal dimensions of the retort at all levels, (2) the condition of the retort brickwork at all levels based on a "brick to brick" examination, (3) the condition of the combustion chambers, and (4) any other peculiar features. G. considers especially the behavior of silica and siliceous products in the vertical retorts. The visual examination of the retort brickwork indicates (1) the amount of flaking and spalling, (2) the nature and amount of slag attack, (3) the behavior of the cement in the joints, and (4) the probable causes of any observed "holing" including failure of the cement joints followed by the spalling of the corners in the early stages of the working. The extent of slag action depends on (1) the nature of inorganic constituents of the coal, (2) the design of the retort, and (3) the manipulation of the retorts, particularly with respect to the temperature of working and the extent of steaming. Slagging action may be injurious in causing (1) erosion or rubbing away of the slagged surface by the charge, (2) failure of brickwork through acute slag penetration, and (3) sticking of the charge. The ability of siliceous and silica products to absorb ferruginous slag is a good property, preventing slag accumulation on the surface. Spalling often occurs in the zone 6 to 12 ft. from the top of the retort. Spalling can be regarded as the failure of a refractory to withstand, without rupture, those stresses induced by temperature fluctuations or thermal shock. Many retort troubles start at the joints. If these are thick and the cement weak, the latter can be forced out and the refractory caused to spall. Leakage followed by holing will probably result. All cold retorts

should be reconditioned before starting to work. Pointing and washing with a silica cement are valuable operations. G.R.S.

Activities of the Society of British Industries, with reference to refractories. FRANK WEST. *Gas Jour.*, **192** [3523], 587–92 (1930).—A brief review of the activities of the Society of British Gas Industries is followed by a discussion of the refractory materials used in the furnaces and settings of the carbonization plant for the manufacture of gas, and in furnaces for the industrial utilization of gas and other allied purposes. Clay retorts were probably first manufactured in Scotland about 1816 to 1820, while silica gas retorts were first made about 1880. The technique of the manufacturer of refractory materials is progressing. The importance of homogeneity, texture, and final constitution to their behavior in industry has led to scientific control of manufacturing processes from the selection of the raw material to the cooling of the goods after firing. Standardization of refractories is carefully considered and the difficulties in attempting standardization are pointed out. G.R.S.

Discussion on "Causes and prevention of bulging in hand-molded refractory shapes." JOSEF ROBITSCHEK. *Bull. Amer. Ceram. Soc.*, **10** [1], 8–9 (1931).—R. agrees with Richardson (*Jour. Amer. Ceram. Soc.*, **13** [4], 256–71 (1930)) that the primary cause of bulging is the bad structure of the "cut face" of the block, which is on top when the block is molded. This face is not so compact and dense as the opposite bottom of the block and this structural difference causes the trouble. Care in eliminating this difference would help reduce bulging to a great extent. A hand-molding method used in Czechoslovakian and German firebrick plants is described in detail. The chief way to eliminate the real cause of bulging in hand-molded fireclay shapes is to produce even structure on both sides of the shape by tamping on both sides. E.J.V.

Velocity of temperature increase in testing deformation. V. ZEGSHDA. *Trans. Ceram. Research Inst.* [U.S.S.R.], **24**, 8 pp. (1930).—Z. describes tests made to determine the velocity of temperature increase while testing the deformation of refractory clays under pressure and at high temperatures. The results of tests differ greatly with different velocities of temperature increase. This difference appears chiefly between the velocity of 5° and 10° per min. Between the temperature increase of 1° and 5° per min. this difference is not noticeable. Therefore the velocity of temperature increase must not exceed 5° per min. when determining deformation. M.V.K.

Theory of heat exchange in regenerators. H. HANSEN. *Z. angew. Mat. & Mech.*, **9** [3], 173–200 (1929); *Sprechsaal*, **63** [48], 918 (1930).—A discussion of the theory of heat exchange in regenerators is given with tables and diagrams. See also *Ceram. Abs.*, **9** [5], 389 (1930). M.V.K.

High temperatures. E. RYSCHKEVITSCH. *Giorn. chim. ind. applicata*, **12** [11], 562–63 (1930); for abstract see *Ceram. Abs.*, **9** [9], 763 (1930). M.V.K.

Relations between strength and temperature for refractory materials. H. HIRSCH. *Ber. deut. keram. Ges.*, **11** [3], 156 (1930).—More brick, especially of foreign origin, are tested and the data published. For previous abstract see *Ceram. Abs.*, **8** [3], 192 (1929). I.R.

Formation of mullite in refractories. P. P. BUDNIKOFF AND B. A. HISCH. *Refrac. Jour.*, **6** [63], 112 (1930); for abstract see *Ceram. Abs.*, **9** [11], 942 (1930). E.P.R.

Testing sagger mixtures. E. KIEFFER. *Ber. deut. keram. Ges.*, **11** [3], 152 (1930).—This is a report of the section for testing saggers of the German Ceramic Society. A questionnaire has been sent out to all plants that coöperated. I.R.

Resistance of refractories. W. MIEHR, J. KRATZERT, AND P. KOCH. *Gas Age-Rec.*, **67** [1], 12 (1931); *Refrac. Jour.*, **6** [63], 112 (1930); for abstract see *Ceram. Abs.*, **9** [10], 847 (1930). E.J.V.

Magnesite cupels. R. J. B. KETHEL. *Jour. Chem., Met., & Mining Soc. S. Africa*

30, 323–29 (1930); *Analyst*, **55**, 658 (1930).—Magnesite is mixed with a little warm water, and as the cupels come from the machine, they are dipped in a 1% sodium silicate solution, and dried at 100°C for 12 hr. H.H.S.

Grog and its functions. C. R. F. THRELFALL. *Brit. Clayworker*, **39** [463], 310–16 (1930); for abstract see *Ceram. Abs.*, **10** [1], 41 (1931). R.A.H.

Iron-foundry refractories. W. M. COHN. *Refrac. Jour.*, **6** [63], 112 (1930); for abstract see *Ceram. Abs.*, **10** [1], 44 (1931). E.P.R.

High-silica retorts at the Rose Lake smelter. GEORGE L. SPENCER, JR. *Mining & Met.*, **12** [289], 22–24 (1931).—S. opens with a general discussion of the importance of retorts and the requisites of a satisfactory retort. Data are given on the sources and properties of the various materials used in the manufacture of high-silica retorts, with details of the preparation of each material before mixing and subsequent manufacture of the retort mix. The method of forming a retort is described together with a discussion of drying, showing important factors such as time, temperature, and losses, the manner of preheating dried retorts, and a discussion of the importance of this operation. A chart is included which shows the temperature curves of preheating kilns. The advantages of high-silica retorts are pointed out. E.J.V.

Application of tensile strength to study of bonding of refractory materials. J. H. CHESTERS AND W. J. REES. *Refrac. Jour.*, **6** [61], 112 (1930); for abstract see *Ceram. Abs.*, **10** [1], 38 (1931). E.P.R.

Thermal expansion of fire brick and silica brick. J. A. SUGDEN AND J. W. COBB. *Refrac. Jour.*, **6** [63], 112 (1930); for abstract see *Ceram. Abs.*, **9** [10], 851 (1930). E.P.R.

Progress in the field of refractory materials. E. H. SCHULZ, F. HARTMANN, AND A. KANZ. *Stahl Eisen*, **50** [48], 1677–81 (1930).—The progress made in the refractory industry throughout the world is discussed in regard to (1) raw materials, their properties, and preparation; (2) kiln construction and operation; (3) testing methods and contrivances; (4) properties of refractory materials; (5) standard specifications; (6) separate blocks, new refractory materials; (7) mortars, cements, and sand for molding; and (8) literature. M.V.K.

Storage of refractory blocks in plants. HANS KREMSKI. *Tonind.-Ztg.*, **54** [96], 1495–96 (1930).—Storing refractory objects after their manufacture is necessary to increase their resistance to changing weather conditions. M.V.K.

Firebrick making in Rhodesia. PERCY W. DUCKENFIELD. *Refrac. Jour.*, **6** [63], 102–104 (1930).—The Wankie Colliery Co., Ltd., of Rhodesia manufactures either fire brick or red building brick as required. Wankie possesses silica deposits from which it would be possible to manufacture, should the demand arise, silica brick of any description. E.P.R.

History of Strasburg firebrick district. E. J. BOGNAR. *Bull. Amer. Ceram. Soc.*, **10** [1], 3–7 (1931).—The well-known Strasburg District, which produces approximately 72,000,000 nine-inch firebrick equivalents per year, is one of the most outstanding firebrick districts in the U.S. and perhaps the largest producer of the so-called intermediate-duty or second-quality refractory. The entire district operates in the lower Kittanning clay, or No. 5. Geologic, chemical, and physical data regarding this clay are given in detail. A history of the development of this district from the time the first plant was built in 1867 to the present is given briefly. Illustrated. E.J.V.

BULLETINS

Concentration of chromite. H. A. DOERNER. Bur. Mines, *Rept. of Invest.*, No. 3049, 8 pp. (1930).—The pure mineral chromite, $FeO \cdot Cr_2O_3$, consists of ferrous and chromic oxides, chemically united in equal molecular proportions. In most chrome

ores the mineral may be considered a combination of spinel and chromite with the latter predominating. In the mechanical concentration of chromite ores the maximum grade of concentrates that can be produced is thus limited by the composition of the chrome minerals present. Pure chromite contains 68% Cr_2O_3, but the Cr_2O_3 content of the chrome minerals in commercial ores varies between 45 and 60%. Chromite is usually associated with serpentine. Other silicates, quartz, lime, dolomite, magnetite, ilmenite, and other iron minerals are frequently present. The amenability of a chrome ore to concentration depends upon the kind and amount of crushing necessary to separate the chromite from them. After proper grinding and classification, tabling will produce a satisfactory separation of chromite from the minerals with which it is usually associated. The presence of low-grade chromite, *i.e.*, chrome spinel, is responsible for most of the limitations of concentration. Either the recovery or grade of concentrates is bound to suffer. A series of tables are given showing the results obtained with ores from various mines. R.A.H.

High-temperature insulation. MOLER PRODUCTS, LTD., London. Pamphlet No. 40; *Refrac. Jour.*, **6** [63], 95 (1930).—This pamphlet shows how insulating with Fosalsil pays. One of the largest manufacturing companies in the South of England insulated with a $4^1/_2$-in. course of Fosalsil "B" grade special flue brick, laid up with Fosalsil insulating mortar, and installed behind a protective course of a $4^1/_2$-in. lining of fire brick. It reduced the radiation losses by 1,049,200 B.t.u. per hour, *i.e.*, an actual saving of 72.4% of the radiation loss. It is now being realized that correct insulation can effect savings in nearly every plant where heat is used. E.P.R.

PATENTS

Making abrasive or refractory articles. PRESCOTT H. WALKER AND SHERMAN S. KENYON. U. S. 1,785,102, Dec. 16, 1930. A method of producing ceramic articles of low permeability which consists in forming a bonded article of granular material and a binder, and then filling the pores of the article throughout the mass with an inorganic heat-resistant substance distinct from the binder.

Preparing pure alumina. TSUNEO SUZUKI, HIROSHI TANAKA, AND TORAO KURITA. U. S. 1,785,464, Dec. 16, 1930. The process of purifying impure alumina containing silicon, iron, ferro-silicon, and oxides of iron as impurities which comprises heating the impure alumina with a carbonaceous reducing agent to reduce the major portion of any iron oxide contained therein and thereafter subjecting the alumina to the action of chlorine gas and carbon monoxide at an elevated temperature until the iron and silicon constituents have been removed as their volatile chlorides.

Open-hearth regenerative furnace. JOHN O. GRIGGS. U. S. 1,785,549, Dec. 16, 1930. An open-hearth regenerative furnace provided at each end with a horizontally-disposed gas port, an air port above the gas port, passages for conducting gas and air to the ports, and a by-pass conduit leading from the air passage to the bottom of the gas port at a point anterior of its outlet, the bottom of the gas port adjacent to but anterior of the outlet of the by-pass being provided with an upwardly extending baffle to cause uniform flow of air from the by-pass into the gas port.

Furnace construction. HARRY DAUM. U. S. 1,786,829, Dec. 30, 1930. The step in the making of furnaces, which comprises installing a wall containing vitrifiable material, and placing a temporary wall in position to deflect a portion only of the gases from contact with the first-named wall, the temporary wall being of such character that it will not be destroyed by the gases until after a glaze has formed on the first-named wall.

Making pure alumina by electrothermal reduction of the impurities in alumina-containing raw materials. HANS SIEGENS. U S. 1,787,124, Dec. 30, 1930. A method

for making pure alumina by electrothermal reduction of the impurities in alumina-containing raw materials comprising the steps of charging the furnace at the beginning of the process with a raw material containing less carbon admixed than is necessary for the reduction of the impurities, then charging with mixtures of raw material and carbon containing increasing amounts of carbon, until the theoretical amount of carbon in the reaction mixture is reached, finishing the charging process with mixtures of raw material and carbon in such amounts that an excess of carbon is present in the reaction mixture, and tapping the liquid-pure alumina at a moment when such an amount of free carbon is still present in the melt that a sample drawn is still light gray but not white and carbon monoxide is developed by the melt, thereby producing during the last period of the heating process a nonoxidizing atmosphere directly above the surface of the melt.

Furnace-wall construction. JOHN E. ANDERSON. U. S. 1,787,464, Jan. 6, 1931. In a furnace construction, an outer retaining wall, an inner refractory lining wall spaced from the outer wall, anchor members embedded in the lining wall, and anchor members embedded in the outer wall and having universal connection with the lining-wall anchor members, whereby the lining wall is free to expand and contract in every direction in the plane thereof independently of the outer wall.

High-temperature cement. ADDIE HUTCHINSON. U. S. 1,787,625, Jan. 6, 1931. A high-temperature cement comprising 15 parts silica sand, 3 parts ground silica brick, 2 parts Portland cement, and $1^1/_2$ parts of soda ash.

Refractory. STUART M. PHELPS AND MACDONALD C. BOOZE. U. S. 1,788,123, Jan. 6, 1931. The method herein described of dealing with alumina-containing material which shrinks excessively in firing consists in mixing with the material phosphate rock in a ratio not exceeding 10%, and calcining the mixture.

Heat and sound insulating materials; refractory materials. M. CASES. Brit. 336,440, Dec. 3, 1930. Nonconducting coverings for heat and sound and refractory materials are formed by the use of a substantial proportion of the residue of combustion of rice chaff. An insulating felt may comprise asbestos 5 to 10%, silicate wool 20 to 40%, product of combustion of rice chaff 50 to 75%, with preferably traces of starch, fused silicates, etc., as binding agents. A refractory material may consist of 60 to 90% of the rice chaff residue, with 40 to 10% of clay, with or without about 2% of fused silicate as a binder. In another example, a mixture of 10 to 40% clay, 2% granulated cork, and 88 to 58% rice chaff residue yields a light porous material from which the cork may be removed by combustion. Nonporous insulating material may be obtained by mixing rice chaff residue with a small proportion of clay, and may be applied externally to buildings to be insulated.

Refractory substances. METALLGES. AKT.-GES. Brit. 337,605, Dec. 24, 1930. Processes for making refractory substances from magnesium silicates, *e.g.*, olivine, serpentine, talc, etc., containing substantial quantities of iron by heating the silicates, without fusion, with substances rich in magnesium, *e.g.*, magnesium oxide and magnesite, in an oxidizing atmosphere. The substances rich in magnesium are present in quantities which are sufficient for the conversion of the whole of the iron into magnesium ferrite and of the free silica into magnesium orthosilicate. The treatment may also be applied to silicates containing, instead of or in addition to iron, other metals such as nickel, manganese, chromium, and aluminium. When silicates which are poorer in magnesium than magnesium orthosilicate are present, the proportion of magnesium oxide, etc., is calculated so that these silicates are converted into magnesium orthosilicate. In some cases the amount of magnesium oxide, etc., is calculated to give an excess of magnesium oxide in the final product. The temperature of heating is below the melting point of the product, generally from 700 to 1500°C. Other substances may be incorporated with the raw materials or with the products, *e.g.*, iron oxide or ores such as magnetite, alu-

minium compounds, *e.g.*, clay, kaolin, and bauxite, and chromium compounds such as chromites. In the manufacture of molded articles, temporary binding agents, *e.g.*, sulphite cellulose waste lyes may be used, and the molding may be effected under high pressure, *e.g.*, 500 to 1000 kg. or more per sq. cm. Materials which on being heated increase in volume, *e.g.*, certain olivines, may be mixed with substances which decrease in volume, *e.g.*, serpentine, to form compositions having the desired change of volume characteristics. In an example, 1000 kg. of a rock containing 800 kg. of an iron-containing olivine and 200 kg. of iron-containing bronzite, with an average content of 10% of FeO are mixed with sufficient magnesium oxide to convert the iron into $MgFe_2O_4$ and the silica into magnesium orthosilicate. The materials are ground to a fineness not exceeding 2 mm. Molding is effected with, if desired, binding agents and high pressure, and the molded article is heated in an oxidizing atmosphere at 1450°C for 6 hr. Other examples are given in the Specification. Specification 301,547 is referred to.

Terra Cotta

Comparison of clay and concrete roofing tile. ANON. *Brit. Clayworker*, **39** [461], 219 (1930).—The English plain clay roofing tile manufacturer has had to meet increasing competition from two sources, the interlocking clay tile and the concrete tile. Comparative data were collected on reputable brands of both products. With "cost," the advantage is slightly with the concrete tile. Laying costs are about the same, although the concrete tile is more difficult to cut resulting in a higher wastage. The weight per unit square is about the same, the concrete tile having an average weight of 36.4 oz. and the clay about 37.5 oz. Transverse strength tests for the concrete tile show an average value of 104 lb. and the modulus of rupture 840 lb. The failing load for clay tile gives an average value of 183 lb. and the modulus of rupture 1248 lb. Permeability measurements are 1.06 and 4.01 for the concrete and clay tile, respectively. The low value for the concrete will tend to make it difficult for the roof to "breathe" and so may lead to excessive condensation of moisture. Two very important and common defects of concrete are its liability to crack and craze, but in small units these defects need not arise if proper care is taken in the manufacture. R.A.H.

New stoneware bodies. III. Thermal expansion up to 1200° and above. W. M. COHN. *Bldg. Sci. Abs.*, **3**, 79–80; for abstract see *Ceram. Abs.*, **9** [6], 446 (1930); see also *Ceram. Abs.*, **9** [9], 791 (1930). (*C.A.*)

Glazes for flowerpots. F. WURTZ. *Keramos*, **9** [23], 871–74 (1930).—Eight compositions for white, blue, red, and yellow glazes for flowerpots are given with directions for their preparation and application. Very good results are obtained. M.V.K.

Plaster casts in ceramics. C. ETTORE. *Ind. Silicati*, **8** [9], 15–16; [10], 10–12 (1930).—Plaster molds and casts used in ceramics chiefly for the reproduction of pieces for architecture and decoration are described. Methods of casting molds in one, two, or more pieces are given. M.V.K.

Standards for white ware. ANON. *Tonind.-Ztg.*, **54** [98], 1524–25 (1930).—Standard specifications are given for the following types of acid-proof white ware: (1) armor pipes, (2) vacuum boilers, and (3) bent, elbow, and T-pieces. M.V.K.

Art and economies of the skyscraper. G. E. J. PISTOR. *Ceram. Age*, **16** [2], 98–102 (1930).—P. gives a history of the development of the skyscraper. In 1887 the Lacoma building, Chicago, was erected, the first real skyscraper supported entirely by a steel frame. Many of the criticisms of skyscrapers are answered. Most foreign architects concede that in the modern skyscraper, America has contributed the most impressive and worth-while style since the Renaissance. A.E.R.W.

New York architects and clay products. ANON. *Brick Clay Rec.*, **77** [14], 772–73 (1930).—New York architects show considerable interest in whatever new products the clay manufacturing industry brings out, but untiring effort on the part of manufacturers is called for in bringing about translation of this interest into specifications. The ideas and opinions of some of the leading architects in regard to clay products are quoted. Illustrated. E.J.V.

Terra cotta building in Canada. ANON. *Pottery Gas.*, **56** [643], 93 (1931).—The building of the Hunter-Henderson Paint Co., Ltd., Vancouver, B.C., is finished in cream terra cotta with colors in the window breasts, green and gold having been "fired" into the material in the polychrome process of manufacture. Illustrated. E.J.V.

BOOKS

Fundamentals of Architectural Design. W. W. TURNER. McGraw-Hill Book Co., Inc., New York. *Arch. & Bldg.*, **62** [10], 306 (1930).—This book is designed as a text-book for college students and a ready reference for architects. E.P.R.

English Monasteries in the Middle Ages. R. LIDDESDALE PALMER. Richard R. Smith, Inc., New York. *Arch. & Bldg.*, **62** [10], 306 (1930).—The sub-title of this book, "An Outline of Monastic Architecture and Custom from the Conquest to the Suppression" limits the period covered by the author. As the subject is presented in this book, the information is collated and put in a form which makes it possible for the reader to get a comprehensive idea of the subject of Monasticism in England without extensive research. E.P.R.

PATENT

Terra cotta article. ADOLPH F. HOTTINGER. U. S. 1,786,753, Dec. 30, 1930. A terra cotta article having an imperforate front face, a plurality of symmetrically-arranged round holes of uniform diameter each having its axis normal to the face and other symmetrically-arranged round holes having their axes normal to the face, the other holes being of less diameter than the first-mentioned holes and disposed in the material defining sets of four of the first-mentioned holes.

White Ware

Nepheline cyanite and nepheline apatite in porcelain industry. V. M. PERMIAKOV. *Ceramics & Glass*, **6** [9], 456 (1930).—P. discusses the possibilities of using nepheline cyanite and nepheline apatite instead of feldspar in the porcelain and faience industries, although these minerals are rich in iron oxide (5 to 6%). Investigations showed that by lowering the iron oxide content to from 0.7 to 0.9% the nepheline cyanite and nepheline apatite, whose deposits are very large in U.S.S.R., can be used with success instead of feldspar for manufacturing porcelain, white ware, and faience. M.V.K.

Glazes without lead. O. V. TCHEREPOFF. *Ceramics & Glass*, **6** [9], 437–38 (1930).—T. describes investigations made to obtain glazes for earthenware without lead. The composition of these glazes is tabulated. Glazes containing MgO are best; they have a smooth, lustrous surface and do not affect the quality of the colors under the glaze. M.V.K.

Spalling resistance of porcelain. R. RIEKE AND H. NAVRATIEL. *Ber. deut. keram. Ges.*, **11** [4], 231 (1930).—The dependency of the spalling resistance of porcelain on shape, size, and thickness of the body has been tested on a large number of plates. Also the influence of substitution of feldspar by a synthetic flux mixture, and the replacement of quartz by refractory oxides and other shortening material were studied. The quartz was in different grain sizes and the clay in the form of different kaolins. It was found

that for most of the mixtures, a raise of the firing temperature or several firings was favorable. The relation between the resistance against spalling and the coefficient of expansion of the microstructure was being determined. It was found that there are some possibilities for the improvement of hard porcelain as far as resistance against spalling is concerned. I.R.

Expedients and accessory objects in porcelain manufacture. LUDWIG HEIN. *Keramos*, **9** [24], 903–905 (1930).—A discussion of gypsum models, preparation and preservation of saggers, and ways of preserving porcelain objects during firing are given. M.V.K.

Designing insulators to combat fog. S. M. JONES. *Elec. World*, **96** [25], 1139–42 (1930).—Salt spray and fogs, fumes, and foreign substances develop no unusual depreciation of insulator glaze on porcelain but they do decrease the effective resistance of the path over the insulators and accordingly decrease their surface-leakage resistance. Various methods of comparing different insulators to determine their adaptability under conditions of fog and dirt have been attempted. Frequent use is made of leakage distance of different insulators on the surface area of the porcelain, combined with the guaranteed flashover values, wet and dry, as a basis of comparison. These factors do not consider the complete insulator characteristic. Suspension string length is an important factor, since it is desired to obtain the maximum insulation in a given space, making tower heights a minimum. Thickness of dielectric must be considered. An engineering comparison indicates that the most insulation, as measured by surface-leakage resistance per dollar of investment, can be obtained by use of the standard short-spaced 10-in. disk, there being a few exceptions for special locations. Periodic cleaning is often necessary and has been successfully accomplished by washing and then drying; also by use of carbon tetrachloride. G.R.S.

Modern plant for electrical insulating ware. ANON. *Chem. Trade Jour.*, **86** [2243], 473–74 (1930); *Sprechsaal*, **63** [48], 915 (1930).—A description of the manufacturing processes of the Steatite and Porcelain Insulators Factory, Ltd., in Stourport, England, is given. The raw materials for high-tension insulators consisting of kaolin, plastic clay, sand, feldspar, steatite, and manganese are carefully tested, ground, and weighed. The fine grinding is done by porcelain blocks in flint mills, from where the mass is blown by pressed air into stirring vessels. The iron particles present are removed by a magnet. The paste is sent into filter presses and the moist pressed cakes remain for 3 or 4 weeks in storage to improve the plasticity. The paste is pugged for several hours and dried with great care. The glazing is done in a specially-constructed automatic machine. Two ring kilns heated with coal, and a tunnel kiln of 97.5 m. length heated by generator gas are used for firing. Low-tension insulators, incandescent mantle rings, and burner nozzles are prepared from steatite which has a shrinkage of 8% only, a great advantage over porcelain with a shrinkage of 18%. Tests for the finished products are severe. A weight of 3780 kg./sq. cm. is used to test the tensile strength. Porosity is also tested; the unglazed porcelain is subjected to a pressure of 400 atmospheres in a fuchsine solution. In the laboratory for high-tension testing, tensions up to 1 million volts are obtained with transformers. M.V.K.

Slip-house practice for semivitreous ware. V. J. ROEHM. *Ceram. Ind.*, **15** [6], 596 (1930).—R. outlines the slip-house practice in use at the Sebring Pottery Co. He emphasizes the proper selection and operation of slip-house equipment and discusses the flow sheet used. The use of rotary lawns allows heavier slip to be used, thus shortening the filter-pressing time. W.W.M.

Modern tile plant uses continuous gas-fired kilns. J. B. NEALEY. *Ceram. Age*, **16** [2], 83–86 (1930); for abstract see *Ceram. Abs.*, **9** [9], 765 (1930). A.E.R.W.

Processes of Mayer China Co. ANON. *Ceram. Ind.*, **15** [6], 585 (1930).—The

printing and decalcomania methods of producing designs on the ware are described in detail. Periodic kilns have been replaced by two tunnel kilns in the new plant. Several unique processes in the production of hotel china at this plant are described. Illustrated. W.W.M.

Modern French porcelain. G. M. GOLDMAN. *Ceram. Age*, **16** [2], 79–82 (1930).—There are new tendencies in the porcelain industry of France: the new forms do not tire the eye or jar the consciousness; there is close coöperation between furniture making, carpet weaving, etc., and ceramic production. Translucent porcelains for lighting purposes and porcelain for garden use are produced. A.E.R.W.

CIRCULAR

Selection of Dinnerware for the Home. ARTHUR S. WATTS. O.S.U. Eng. Expt. Sta., *Circular*, No. 21, 14 pp. (1930).—Dinnerware is classified as follows: (1) earthenware, a porous nontranslucent ware with a soft glaze; (2) china, a commercially vitrified translucent ware with a soft glaze which resists scratching to a greater or less degree; and (3) porcelain, a thoroughly vitrified, translucent ware with a hard glaze which resists scratching to the maximum degree. The various kinds of ware that come under these three main classifications are discussed and their differences pointed out. The various methods of decoration used are explained and discussed as to durability, etc. Grades of ware based on the degree of perfection are enumerated. Some of the common faults of the various dinnerware are pointed out. The type of ware, class of decoration, and amount and grade of labor employed are the controlling factors in the cost of dinnerware. All types are obtainable in all grades and the cost of the ware is no indication of its service qualities. This publication explains many points which are not generally known by the layman and does so in a nontechnical manner so that it is readily comprehensible. E.J.V.

PATENTS

Electric condenser. JOHN A. PROCTOR AND WILLIAM M. BAILEY. U. S. 17,916, Dec. 30, 1930 (reissue). The combination with an electrical-condenser stack to be enclosed and compressed, of a porcelain casing surrounding the stack, a clamping terminal located inside the casing at one end of the stack; and a device located inside the casing at the other end of the stack and forcing the stack against the clamping terminal and thereby against the casing as a tension member of means clamping the stack.

Water-closet bowl. HOWARD F. KELSO. U. S. 1,785,198, Dec. 16, 1930. A water-closet bowl having a trap formed with an outlet passageway through which the contents of the bowl may be discharged, there being inlet side channels terminating in series of correspondingly-inclined outlet openings arranged about the outlet passageway and also a passageway leading from each channel and merging into common outlet openings arranged about the bowl, the outlet openings being disposed to direct the flushing fluid in spiralled fashion about the walls of the bowl and outlet passageway, respectively.

Pottery compositions. J. E. TAMS. Brit. 336,172, Dec. 3, 1930. A semiporcelain body comprises approximately 50 parts of asbestos powder, 40 parts of ball clay, and either 20 parts of ground stone or feldspar or 10 parts of both ground stone and feldspar. The materials are blunged with water into a slip or plastic mass for treatment in the usual way. Specification 228,058 is referred to.

Polishing molded earthenware, etc. G. WADE & SON, LTD., AND G. A. WADE. Brit. 336,396, Dec. 3, 1930. Molded articles, particularly earthenware or pottery articles such as bottle stoppers, are trimmed and polished by attrition caused by traversing the article in a zigzag path between adjustable guides over a damp conveyer made of flannel, etc. The conveyer is driven by rollers and moves through water in a bath. The guides

are adjustably mounted on rods which are longitudinally and angularly adjustable relatively to a slot. The guides may be provided with bevelled ends and are fitted with blade springs adapted to press the articles upon the conveyer with pressure controlled by springs and adjustable stops. The articles are fed to the conveyer by a chute and are discharged onto a table by a curved guide. Tile may be treated by traversing them between conveyers moving in the same or in opposite directions at different speeds. Vertically-disposed conveyers may be employed to treat the edges of the tile.

Equipment and Apparatus

New autoclave with closed porcelain pot. ANON. *Chem.-Ztg.*, **54** [103], 997 (1930).—The new Universal autoclave with a closed porcelain pot is described. It can be used for solutions containing ammonia or acids without injury. M.V.K.

Measuring tension in fired ceramic mixes. W. STEGER. *Ber. deut. keram. Ges.*, **11** [3], 124 (1930).—The presence of tension in glazed bodies is evidenced by cracking and rolling off of the glaze. S. developed a new method for measuring the tension between glaze and body to give plant control and also to understand how to eliminate these tensions. Conclusions are as follows: (1) Tension in glazed and unglazed ceramic mixtures can be measured. (2) The heating must be done up to that temperature in which the strain in the mixtures or the glazes is released in order to develop a phase free from tension. (3) Deformation of a number of ceramic mixtures during the sag test will occur below 1000°. Softening with raising temperature can be given in curves characteristic for each mixture. (4) Even slight vitrification of the surface of unglazed ceramic mixtures, *e.g.*, the firing film, will develop measurable tension. The measuring of these tensions will give approximate data on temperatures in which the tension of ceramic mixtures is relieved. (5) The change of tension between earthenware mixtures and glazes differs with the temperature according to whether the glazed body is heated or cooled. During slow cooling the tension between body and glaze is constant at ordinary temperature. At rapid cooling (quenching) of glazed earthenware from the temperature above that at which the tension of the glaze is released, there will always occur an increase in the tension between body and glaze to the side of the splitting off. Glazes with a tendency to crack can be made free of cracks by rapid cooling. The tendency to splitting off will become larger by rapid cooling. Quenching from the temperature which is below that temperature at which the tension is set free, will not have this influence. (6) Glazes of the same chemical composition and made from the same raw materials will have different tension with the same body, depending on whether they are fritted or unfritted. (7) At the same composition of the glaze the addition of tin oxide will favor the fritting of the glaze without crazing. This addition will not decrease the heat expansion of the dull glaze. (8) Porcelain glazes are fundamentally different from earthenware glazes insofar as the tension curves will have the same run during the heating and cooling. I.R.

Electrofiltration: Method of removing exchangeable bases from soil colloids. A. N. PURI. *Soil Sci.*, **30** [6], 413–19 (1930).—A simplification of the Mattson cell is proposed, two types of apparatus being described. Electrofiltration apparatus *A* is cylindrical in form, having a perforated copper disk cathode and a platinum gauze anode. A filter paper is placed on the copper disk. The cylinder contains a U-tube for circulating cold water when a determination is being made. Current density is kept below 0.5 ampere. Ten to twenty grams of soil can be used at a time and the filtration is fairly rapid. When the filtrate gives no color with phenolphthalein all exchangeable bases have been removed. There is no limit to the size of the apparatus, one being constructed to handle 500 g. of soil. Apparatus *B* is much simpler and is suitable for preparing soils free from exchangeable bases. It consists of a funnel and a perforated

copper cone which serves as the cathode. A platinum gauze anode is used. A filter paper is fitted into the copper cone, and after the cone is filled with soil suspension, the electrodes are connected with the source of current. Sometimes filtration is too rapid and a stopcock attached to the funnel is required to regulate the flow. Electrofiltration can be used as a preliminary treatment of the soil for mechanical analysis and gives closely agreeing values for clay with the (NaCl-NaOH) method and the 0.05 *N* HCl method, which have already been shown to effect complete dispersion of soil colloids. G.R.S.

Broad source of monochromatic light. M. J. Buerger and V. F. Harrington. *Amer. Mineralogist*, **15** [12], 579–80 (1930).—Photographs show a remodeled Terrill burner. The broad flame produced makes it superior for use with the microscope. Gauze troughs of nickel may be substituted for those of platinum but do not last as long. The largest flame may be had if the air adjustment be fully opened and the gas adjusted to just remove the blue cone. G.R.S.

The plastometer. Joseph D. Davis. *Gas Age-Rec.*, **66** [25], 977 (1930); reprinted from *Gas Jour.*; for abstract see *Ceram. Abs.*, **9** [12], 1069 (1930). E.J.V.

Universal camera for structural investigations. Carl Leiss. *Z. Physik*, **61** [9], 663–66 (1930).—A detailed description is given of a new type of camera for studying materials by the X-ray method. It may be used for the study of powder photographs by the Debye-Scherrer method, for the photography of crystals by the rotation method, and for the study of very thin rods or wires of a material. The article is illustrated with photographs of the apparatus. L.T.B.

Bulb-type rectifiers charge control batteries. E. A. Hoxie. *Power*, **72** [18], 684–85 (1930).—Bulb-type rectifiers are being used to supply a small current to maintain control batteries in a charged condition. Various methods of application are described. H.W.A.

Efficiency of air separators. H. Madel. *Zement*, **19** [41], 958–63 (1930); *Rock Prod.*, **33** [25], 76 (1930).—Rosin and Rammler dealt some time ago (*Zement*, Nos. 26 and 32 (1929)) with the theory of efficiency of air separation and established three formulas for use in determining the efficiency of air separators. At this time, M. presents a constructive criticism of this work and adapts the formulas which are being used by the German Technical Committee on Ore Preparation, for use in determining the efficiency of air separators, in order to improve or supplement the work of Rosin and Rammler (see *Ceram. Abs.*, **9** [3], 218 (1930)). He proves the formulas by use of plane diagrams. This criticism is favorably received in an appended discussion by Rosin and Rammler. W.W.M.

Apparatus for determination of grain sizes according to the pipette method. A. H. M. Andreasen and J. J. V. Lundberg. *Ber. deut. keram. Ges.*, **11** [5], 250 (1930).—A new method has been developed, based on an apparatus from Atterberg, which consists of a cylindrical bottle into which a pipette with a cock and a little side pipe to let out the water is attached. The principle of this apparatus is to take out from the sedimentated sample after certain time intervals, certain quantities and to determine their grain composition. The mathematical foundation of this principle and some data on the tests made with this apparatus, *e.g.*, kaolin, barium sulphate, quartz, etc., are given. It seems that this method might be successfully applied to plants. I.R.

Control system assures uniform feed to kilns. Anon. *Pit & Quarry*, **21** [6], 75–76 (1930).—The Bendy feed-control system, recently introduced, assures a constant and uniform feed to a cement kiln per kiln revolution. E.P.R.

Totally inclosed, fan-cooled induction motor. Anon. *Elec. World*, **96** [25], 1154 (1930).—A totally inclosed, double fan-cooled motor which embodies new and unusual features has recently been announced by the Lincoln Electric Co., Cleveland, Ohio. G.R.S.

Counter-current rapid mixer. ANON. *Tonind.-Ztg.*, **54** [97], 1514 (1930).—A new counter-current rapid mixer of "Bauart Eirich" is described. It mixes all different kinds of clays to a complete homogeneity. M.V.K.

Recent technical developments in nonmetallic mineral industries. OLIVER BOWLES. *Mining & Met.*, **12** [289], 39–41 (1931).—Recognition is now being given to the advantages of closed-circuit grinding of cement raw materials in wet-process plants, with stage removal of the fine materials, increasing mill capacity, reducing the wear of grinding media, and also reducing the power requirement. In wet-process cement plants filters are being used to dewater the slurry, resulting in marked reduction in water content which increases plant capacity, reduces the fuel requirements, prevents the formation of mud rings in the kilns, and provides a better clinker. The wet process of clay purification by settling has been almost universally used. Recently the use of dry centrifugal air separators for removing sand, mica, and other impurities in white-paper clays has met with considerable success. Five operations are involved: (1) air drying, (2) coarse grinding, (3) complete drying, (4) pulverizing, and (5) air separation of impurities. High-alumina brick of various types, ranging in Al_2O_3 content from 50 to 80%, will resist the erosive action of fluid slags remarkably well. They are therefore finding much wider use in lining electric and reverberatory furnaces for melting both ferrous and nonferrous metals and alloys. Progress in fireclay refractories is chiefly in the more general adoption of the power-press or dry-press process, giving brick of exact size and shape. Higher pressures have been found to yield better results in the manufacture of magnesite brick. Dead-burned dolomite, used in place of magnesite, is commonly prepared by grinding dolomite in a wet mill with the addition of fairly definite quantities of iron oxide, alumina, and silica, mainly as fluxing agents and possibly partly for their catalytic action. This slurry is then calcined and clinkered like cement in a rotary kiln. Electromagnetic purification of feldspar recently developed by the Tennessee Mineral Products Co. is noteworthy. Induction separator units form an important part of the equipment used in preparing a free-flowing granular feldspar practically free of impurity, prepared specially for the glass industry. This method of ore treatment is finding application in the concentration of cyanite and other minerals. There is a marked trend in the diatomite industry toward a more complete mechanization of the western operations. Illustrated. E.J.V.

Heavy high-speed grinder. ANON. *Brass World*, **26** [12], 328 (1930).—Hammond Machinery Builders offer a new type of heavy grinder for high-speed operation, in $7^1/_2$-, 10-, and 15-h.p. capacities. The machine is known as the "Select-O-Speed." Many advantages in the way of accessibility, vibrationless operation, and safety features have been incorporated. Other advantages claimed are (1) almost constant peripheral speed of 9000 surface ft. per min., which enables maximum grinding efficiency on bakelite and rubber-bonded wheels, and the machine can also be arranged for use with vitrified grinding wheels; and (2) wheels of 24-, 20-, 18-, and 16-in. diameters can be used effectively. E.P.R.

Extended-spindle grinder. ANON. *Brass World*, **26** [11], 292 (1930).—A new type of grinder with spindle extended to facilitate operation on large work requiring considerable room between wheel and pedestal has been added to the "One Profit" line of machines manufactured by the Production Equipment Co. E.P.R.

Further developments in closed-circuit dry grinding. H. G. WRIGHT. *Rock Prod.*, **33** [26], 46–48 (1930).—W. discusses the advantages of closed-circuit dry grinding with reverse current system of air classification, illustrating his points with photomicrographs. See also *Ceram. Abs.*, **9** [10], 861 (1930). W.W.M.

Important developments made in grinding field. ANON. *Pit & Quarry*, **21** [7], 164 (1930).—Two outstanding developments have been made in the plants of the Traylor

Eng. & Mfg. Co. during the year 1930. One of these is a grinding-classifying system for the grinding of cement both in the raw and finishing departments. The other development is a new reduction crusher styled the Type TZ finishing gyratory crusher. E.P.R.

Meco auto pug tender. ANON. *Clay-Worker*, **94** [6], 396 (1930).—This machine will, automatically and with absolute uniformity, feed both the clay and water to the pug mill. It does not require an expert to adjust or operate it. The proportions of clay and water are controlled by an adjustable ratchet for the clay and by setting the overflow valve to the proper level in the water tank. E.J.V.

Efficient pulverizer. ANON. *Pit & Quarry*, **21** [3], 72 (1930); *Chem. Met. Eng.*, **37** [12], 770 (1930).—The Fuller Lehigh Co. has a new Type B pulverizer which is an air-separation ball mill. E.P.R.

Silica pan mills. H. KOBER. *Tonind.-Ztg.*, **54** [100], 1551–52 (1930).—A description is given of different types of mixing mills for silica. M.V.K.

Small colloid mill. ANON. *Chem. Met. Eng.*, **37** [12], 769 (1930).—The manufacture of the Disper mill, a laboratory colloid mill, has been announced by the Diamant Tool and Manufacturing Co., Newark, N. J. The machine is large enough for small-scale plant production, being capable of making emulsions and dispersions at the rate of 20 to 60 gal. per hr. G.R.S.

Speed regulation of rotary cement kilns. ERICH AUERBACH. *Pit & Quarry*, **21** [6], 57–58 (1930); for abstract see *Ceram. Abs.*, **9** [11], 957 (1930). E.P.R.

Cam-operated screen. WILLIAMS PATENT CRUSHER AND PULVERIZER CO. *Chem. Met. Eng.*, **37** [12], 772 (1930); for abstract see *Ceram. Abs.*, **10** [1], 54 (1931). G.R.S.

Predicting the behavior of a babbitt. A. H. LEVY. *Power*, **72** [19], 720–21 (1930).—L. explains which tests are suitable and which are worthless. H.W.A.

Mechanical appliances at clay and sand pits and transport to works. FRANK WEST. *Brit. Clayworker*, **39** [464], 346–50 (1930); *Refrac. Jour.*, **6** [63], 76–83 (1930).—Comparative costs are given on transporting raw materials from pits to works by (1) cart and horse, (2) Fordson tractors, (3) steam lorry, and (4) Fordson locomotive. The lowest cost per ton was obtained in the case of the locomotive. Diggers and excavating machinery and hand vs. machine work are also discussed with cost data and advantages of machine work given. R.A.H.

Use of alloy steels increasing in pit and quarry industries. J. P. WATERS. *Pit & Quarry*, **21** [3], 64 (1930).—Operators are realizing that the life of machinery can be lengthened by specifying alloy-steel construction in new equipment. By adding, in predetermined proportions, one or more of these alloying elements, it is possible to develop almost any desired quality in steel. E.P.R.

German test data on slurry filters. G. BOEHM AND DESIDER STEINER. *Zement*, **19** [33], 768–75 (1930); *Rock Prod.*, **33** [25], 76 (1930).—The rapid adoption of the slurry filter in the American cement industry has proved that it is actually serviceable. In Europe only a few small installations have as yet been made. After a few quite successful preliminary tests, however, a larger slurry-filtering plant was installed about a year ago. Before presenting the test data on this plant, a general exposition is given of the design and operation of slurry filters, referring also to the Oliver and Feinc drum filters, and the American or United disk filter. The slurry filter at the German installation under test, is of the Feinc-Imperial type supplied by the Imperial Machine Works, at Meissen. This firm expects soon to produce a filter combined with a drier, for which a German patent application has been made. A dried filter cake of only 2 to 3% moisture content is to be produced with it in one process, from raw slurry of about 40% water content, which constitutes a complete change from the wet process to the dry process. Air or waste gas of about 200°C is considered sufficient for drying. Due to a favorable

arrangement of the German cement plant, it was possible to cut out the filter equipment at any time and to connect up the slurry feeding tank with the kiln so that comparative operating data could be obtained in the same plant. W.W.M.

Centrifugal flue-dust collectors. ANON. *Mech. World*, **88** [2294], 581 (1930).—Removal of dust from chimney gases is done by means of patent centrifugal collectors. The basic principle upon which these patent collectors operate is essentially that of centrifugal force aided by gravity, using three general types of apparatus according to circumstances, *i.e.*, the *D* (direct), *SP* (shunt pressure), and *SS* (shunt suction). E.P.R.

Reliability of pyrometers. H. MOORE. *Pottery Gaz.*, **56** [643], 81–85 (1931).—Construction and maintenance of optical and radiation pyrometers are described at length. Various possible errors in pyrometers, such as errors in magnification, are discussed. Ideal circuits and variations in pyrometers are taken up. Certain forms of pyrometers cannot be trusted because they are wrongly designed. Uniform furnace conditions must be maintained to get reliable temperature measurements even with the best of pyrometers. E.J.V.

Recording pyrometer. UEHLING INSTRUMENT CO. *Brass World*, **26** [11], 300 (1930); see also *Ceram. Abs.*, **9** [12], 1076 (1930). E.P.R.

Automatic gas mixing for uniform B.t.u. values. CUTLER-HAMMER, INC. *Can. Chem. Met.*, **14** [12], 38 (1930).—"The Calorimixer" has been developed and designed for use where changed conditions, involving the mixing of natural and manufactured gases of different compositions and heating values, necessitate special care to produce the most heat efficiently and economically. Rates of flow, pressures and temperatures, and B.t.u. variations of gases must be watched. This new instrument is said to have almost instantaneous response to changes in B.t.u. of the gas and is used to maintain the desired uniform heating value of the mixture. Illustrated. E.J.V.

New mechanical devices in the potteries. W. E. WELLS. *Pottery Glass & Brass Salesman*, **42** [20], 66 (1930).—W., in an address before the U.S. Potters Assn., stated that a description of newly-developed machinery would be of more value than a discussion of well-known types. He describes a new plaster mixer which replaces the old hand method of mixing, producing a uniform plaster the molds from which, it is considered, will well outlast the hand-mixed plaster. The machine mixes plaster ready to pour at an average of 3 min. as contrasted with 7 min. by the mold maker. W. also discusses the use of automatic speed control as applied to slip pumps. By means of a special pressure regulator it is possible to control the speed of the pump so that any desired pressure in the slip line is accurately maintained. E.P.R.

Clay plant efficiency. ANON. *Brick Clay Rec.*, **77** [14], 785–814 (1930).—This discussion serves as a guide to the changes that have been made in equipment and also points out some of the developments which merit serious consideration on the part of the clay products manufacturer. Detailed discussions are presented under the general headings of pit equipment, clay preparation, molding and shaping, drying progress, firing developments, material handling, and miscellaneous. Illustrated. E.J.V.

Labor reduced by one-third. ERNEST H. ROWE. *Brick Clay Rec.*, **77** [13], 715–16 (1930).—Electric lift-trucks, used at the firebrick plant of M. D. Valentine & Bros. Co., have unmistakably speeded up production and cut down costs. Illustrated. E.J.V.

Variable speed transmission. LINK-BELT CO. *Mining & Met.*, **12** [289], 71–72 (1931); see also *Ceram. Abs.*, **10** [2], 132 (1931). E.J.V.

Electrical power in brickworks. ANON. *Brit. Clayworker*, **39** [463], 291–92 (1930).—Various tools operated by electric power which may be used in brickworks

are described. The advantages and applications of electric welding are also given. For previous abstract see *Ceram. Abs.*, **9** [8], 661 (1930). R.A.H.

Unit system of loading railroad cars. JOHN D. MARTIN. *Clay-Worker*, **94** [6], 394–95 (1930).—Under the unit-load system four steel straps, $1^1/_4$ in. wide, are used in each car end. One end of each strap is first placed on the car bottom at about the center of the door. Extending along the bottom to the end of the car, it is fastened to the floor, also up the end and fastened to it high enough in a roll to be out of the way of the loaders. A wooden bulkhead of 1-in. lumber, the exact height of the brick load is then placed against the end of the car. When the brick are all in, another bulkhead is placed against the brick last loaded, the bands are loosened from the floor and from the end of the car, brought together over the top of the load, pulled tight, and fastened together with special tools for this purpose. Illustrated. E.J.V.

Tractor-operated equipment. CLARK TRUCTRACTOR CO. *Chem. Met. Eng.*, **37** [12], 773 (1930); see also *Ceram. Abs.*, **10** [1], 54 (1931). G.R.S.

List of permissible mine equipment. L. C. ILSLEY. Bur. Mines, *Information Circ.*, No. 6347, 12 pp. (1930).—This report lists all permissible mine equipment approved by the Bur. of Mines up to and including July 1, 1930. For previous abstract see *Ceram. Abs.*, **9** [5], 391 (1930). R.A.H.

Special steels for ceramic equipment manufacture. A. W. F. GREEN. *Ceram. Age*, **16** [3], 141–46 (1930).—G. discusses steel for all sorts of machinery parts used in ceramics. Illustrated. A.E.R.W.

Repairing presses in ceramic industry. C. DORNEDDEN. *Sprechsaal*, **63** [48], 909–12 (1930).—Ways of preventing breaking and ways of repairing presses used in the ceramic industry are discussed. M.V.K.

BOOKS AND PAMPHLETS

Die Design and Die-Making Practice. FRANKLIN D. JONES. Industrial Press New York, 1930. 921 pp. Illustrated. $6.00. Reviewed in *Mining & Met.*, **12** [289], 18 (1931).—This book describes current practice in making dies for blanking, forming, and drawing sheet metal, and illustrates the principles by many examples of standard and special dies. It brings together a large amount of experience that is not readily available elsewhere. E.J.V.

Monarch-Keller Lathes. MONARCH MACHINE TOOL CO. *Amer. Glass Rev.*, **50** [15], 37 (1931).—The Monarch Machine Tool Co. has designed a lathe equipped with Keller electrical control which is especially suitable for making bottle molds, lens grinding dies, punches and dies for hollow ware, composition mold dies, circular-formed cutters, etc. E.P.R.

Raymond kiln mill. ANON. *Pit & Quarry*, **21** [7], 169 (1930).—The Raymond Bros. Impact Pulverizer Co. has issued a pamphlet describing and illustrating the wide possibilities of this machine which dries and pulverizes materials in a single operation. E.P.R.

PATENTS

Tank for chromium plating. C. ROY GLEASON. U. S. 1,784,987, Dec. 16, 1930. A tank for containing the electrolyte for use in the electrodeposition of chromium, comprising a container composed of any suitable material and a lining of lead and then a lining of glass.

Dust collection. CLARK T. MORSE AND EDWARD L. HOGAN. U. S. 1,785,453, Dec. 16, 1930. In a method of dust collection, incorporating moisture with a dust-laden gas stream, subjecting the stream to centrifugal action comprising moving the dust and moisture in a continuous path, extracting the clean gas therefrom by moving the dust-

laden gas in a horizontal path for approximately a revolution, conveying it to a next lower horizontal level, again moving it in a horizontal plane in a path of lesser diameter than that of the first, the path becoming increasingly closer to the center of revolution of the stream and continuing this operation until the center of the stream is reached, and dropping the moisture-laden dust by gravity downwardly through the center of the stream and discharging the dust-free gas upwardly in a path which is the prolongation of the central portion of the stream.

Testing clays, etc. JOSEPH F. MACKIN. U. S. 1,785,521, Dec. 16, 1930. A device for testing the bonding strength of plastics, etc., including a base, a table pivoted on the base, a bed adapted to receive the material to be tested, a compression member carried by the table to coöperate with the material-receiving bed and a slidable weight on the table serving to separate the compression member from the material tested and indicate the bonding strength thereof.

Air-conditioning system. CARROLL E. LEWIS. U. S. 1,785,741, Dec. 23, 1930. In an air-conditioning system, a device for controlling delivery of liquid to a humidifier, a humidity-actuated regulator, connections between the regulator and the delivery-control device, a heating medium, a thermally actuated regulator subjected to the heating medium and connections between the last-mentioned regulator and the humidity-actuated regulator to render the humidity regulator operative.

Manufacturing artificial aggregate for mortars and concretes. JOHN E. GREENAWALT. U. S. 1,786,713, Dec. 30, 1930. The process of manufacturing a concrete aggregate which comprises mixing finely-crushed clay and cinders, charging the mixture in a suitable vessel, passing a combustion-supporting gas therethrough, igniting the charge at its surface, and continuing to pass the combustion-supporting gas through the charge until the same is sintered.

Sintering clay. JOHN E. GREENAWALT. U.S. 1,786,714, Dec. 30, 1930. The process of manufacturing an aggregate for mortars or concretes, which comprises reducing argillaceous material to a finely-divided condition, adding water thereto to form an agglutinated mixture, converting the mixture into a homogeneous mass of small bodies, and arranging the bodies on a permeable hearth to form a charge, effecting a distribution of fuel throughout the charge, igniting the fuel at one surface of the charge, causing a supporter of combustion to pass through the charge away from the ignited surface, whereupon combustion of the fuel will proceed through the charge and produce a hard, porous, fired product.

Chromium plating. JOHN A. HANLEY AND WALTER L. PINNER. U. S. 1,787,477, Jan. 6, 1931. In a process for chromium plating, the succession of steps comprising cleaning the article as a cathode in an alkaline bath, dipping in an acid bath, rinsing, placing immediately in a chromium-plating solution, and turning on the current when the article has been in the solution about five seconds.

Manufacturing electrical resistance element. ALBERT H. HEYROTH. U. S. 1,787,749, Jan. 6, 1931. Method of manufacturing a heat-hardened electrical resistance element, which comprises forming a shaped body of a mixture including silicon carbide between 75 and 45%, carbon between 0 and 20%, and bentonite between 25 and 45%, heating the formed body at a temperature between 2100°F and 2500°F for a period of time sufficient to insure the production on the surface of the element of an insulating sealing shell which is a reaction product of one or more of the ingredients of the body, and continuing the heating operation for a period sufficient to consolidate and heat-harden interior portions of the element.

Compartment-tube grinding mill. JOSEPH V. DURNIN. U. S. 1,787,897, Jan. 6, 1931. In a compartment-tube grinding mill, a casing, an adjustable partition arranged therein, comprising a spider, discharge-plate means secured to one side of the

spider and having openings for the passage of material, a plurality of cover plates arranged within the spider and disposed adjacent to the discharge-plate means and having openings adapted for movement into and out of registration with the first-named openings, means to shift the cover plates with relation to the discharge-plate means, and inlet-plate means secured to the opposite side of the spider and having a central opening for the passage of the material.

Producing resistance unit. CARROLL H. BOYLES. U. S. 1,788,146, Jan. 6, 1931. The method of producing a resistance unit consisting of mixing together 46 to 80% carbon, 52 to 12% pulverized carbide of boron, and 2 to 8% sodium silicate, molding the mixture into a desired form, subjecting the mixture to a high pressure, heating the mixture to a temperature of 1200 to 1400°F for 24 to 48 hr., mixing a second compound of 85 to 98% corundum and 15 to 2% sodium silicate, molding this compound around the first compound, subjecting the product to a high pressure, and heating the product to 1800 to 2000°F for 18 to 36 hr.

Kilns, Furnaces, Fuels, and Combustion

Continuous kilns for firing clay products. J. WILLIAMSON. *Brit. Clayworker*, **39** [462], 274–78 (1930).—The intermittent kiln is the most economical type for small output. Continuous kilns differ in types. Clay differs in composition and requires a different heat treatment. The continuous kilns permit the economical passing of a larger volume of air through the ware than any other type. Products which require a reducing atmosphere are difficult to fire in a continuous kiln. The "Manchester" kiln, an improved Hoffman kiln, is universally used in England for common brick. It is easy to control, is simple in construction, cheap to build, and will use cheaper grades of fuel. The "Super-Staffordshire" kiln has met with favor in firing face brick, terra cotta, and roofing tile where uniformity of color is desirable. The "Ideal" kiln is excellent fol common brick, face brick, tile, and drain pipe. There are four distinct types of tunner kilns: (1) direct longitudinal flame, (2) muffle, (3) combined direct flame and muffle, with the flame in direct contact with the goods in the hot zone, afterward entering side flues and heating by radiation, conduction, and convection, and (4) electric kiln. Although tunnel kilns are used for silica brick, the chamber kiln is more suitable for placing large and irregular shapes, besides being more economical in fuel and better suited for high temperatures and long soaking and cooling periods. The factors in favor of the continuous kiln are (1) 50% saving in fuel is a fair estimate, even 70% being recorded; (2) 30 to 60% saving in labor; (3) control is easier; (4) the product is more uniform; (5) losses are reduced almost to the vanishing point; and (6) repairs are low and greater output is obtained for a given space. R.A.H.

Overhead-flame kilns. A. NAWRATH. *Tonind.-Ztg.*, **54** [98], 1519–20 (1930).—Advantages of overhead-flame kilns over other kilns are (1) they produce uniform firing; (2) the fine point of the flame does not reach the ware; (3) the heat is divided uniformly over the charge; and (4) since the upper layers of ware receiving the greatest part of the heat have no weight on them, they do not change their shape as easily as in other kilns. Overhead-flame kilns are therefore used for firing ware of high quality and for ware requiring a high finishing firing such as grog, white ware, and clinker. A description of single periodical kilns with overhead flame is given. Great fuel consumption in overhead-flame kilns is avoided by joining several kilns together in such a way that the hot gases of one kiln are passed to another kiln for heating the ware. In firing porcelain, the firing gases of the round kiln with overhead flame enter 2 or 3 superimposed chambers, the first chamber being used for finishing firing, the second for heating the ware to redness, and the third for prefiring saggers. The chimney is put on the crown

of the last chamber. There are also chamber ring kilns with overhead flame, having a great output, and used for firing road clinker. These clinkers are rendered exceptionally solid and durable by slow cooling after the finishing firing. Chamber ring kilns with overhead flame heated by gas are also used with great success for firing ware requiring high finishing firing temperatures. M.V.K.

Recent trend of ceramic kiln practice. S. R. HIND. *Brit. Clayworker*, **39** [460], 184–91 (1930).—During the last few years considerable progress has been made in the adoption of improved methods of firing ceramic ware. Car tunnel kilns are increasing at an accelerated rate and renewed attention is being paid to the best methods of constructing and operating various forms of intermittent kilns. H. reviews and discusses (1) the flow of gases in kilns and ovens; (2) fuels, grates, and smoke; (3) flat or suspended kiln arches; (4) thermal insulation; (5) draft gages and gas sampling; (6) temperature measurement and control; (7) firing properties of clays; (8) intermittent kilns; (9) continuous kilns of the moving fire type; (10) continuous-car tunnel kilns other than electric; (11) Dressler kilns; (12) Woodall-Duckham kilns; (13) Robertson kilns; (14) Harrop kilns; (15) Koppers kilns; (16) pottery-decorating kilns heated by electricity; and (17) various other kilns not so well known. See also *Ceram. Abs.*, **9**[11], 962 (1930). R.A.H.

Setting damp brick in the kiln. ANON. *Brit. Clayworker*, **39** [463], 290 (1930).—The question often arises how damp a brick made by the stiff-plastic process should be in order to set it in the kiln with a minimum risk of loss. A continuous kiln should always have sufficient chambers so that two of them can be used for drying off or smoking. This drying should be done with wicket fires when a hot air system is not available. A gentle current of air must continuously pass over the ware, but too much air will cause the brick to crack. Air forced into the drying chamber is probably more successful for high production than the drawing off of the air. The warm air should enter near the top of the ware and be drawn off near the bottom. It is best never to put damp brick into a kiln, but where necessity demands such a practice, the greatest possible care should be taken to dry them in the kiln before proceeding with the firing. R.A.H.

Report on red roofing-tile oven. W. EMERY. *Brit. Clayworker*, **39** [464], 351–57 (1930).—The study was undertaken at a plant manufacturing handmade roofing tile. The dimensions of a circular intermittent downdraft kiln used and the method of setting the kiln are given. It was found that the amount of fuel used during the period of water-smoking was approximately $^1/_6$ of the total consumption, but 82% of the total firing time is expended during this period. A series of tables give data on heat lost and accounted for in the various stages of firing the ware. R.A.H.

Temperature measuring in ring kilns. W. LIESEGANG. *Ber. deut. keram. Ges.*, **11** [4], 220 (1930).—The heat technical supervision of ring kilns is possible with the help of pyrometric and thermoelectric measuring methods. In this article, experiences on coal-fired as well as gas-fired kilns are described. There are a number of advantages in conducting the fire according to one scheme developed in advance. It is possible to lower the losses by putting the measuring devices in carefully. The time of amortization of these instruments is only a few months. I.R.

Managing the producer in gas-fired kilns. ANON. *Brit. Clayworker*, **39** [461], 209–10 (1930).—The chief difference between working a gas-fired and a coal-fired kiln is in the producer. If this is well managed excellent control of the kiln is easy, but with a poor gas man innumerable troubles may ensue. A simple gas producer is the most desirable. A mechanically-fed producer is a little better than a good gas man. The fuel should be suitable for the goods to be fired. Coals evolving a large proportion of hydrocarbons should be avoided because of the soot which is deposited in the gas duct. A common mistake is to stoke too heavily or at too long intervals resulting in poor gas.

A good gas should contain 40% of combustibles. About 5 lb. of coal for each pound of dry steam consumed is good practice. The air supply should be controlled independently of the steam. The gas temperature should be about 1200°F. R.A.H.

Determining proper diameter of gas producer mains. J. W. ROMIG. *Ceram. Ind.*, **15** [6], 615–17 (1930).—Gas mains which are too small are a handicap to proper furnace operation; those which are too large cost more to install and cause an excessive loss in gas temperature. R. presents some views on gas main design with a detailed example of all calculations encountered in computing the areas required for delivery of a given amount of producer gas. The volume of gas (and accompanying water vapor) produced by the coal is calculated at 60°F. The volume of this gas is determined at the temperature at which it will travel through the mains. From this volume and the velocity of the gas, the area of the main is calculated. W.W.M.

Gas-fired kilns. ANON. *Gas World*, **9**, 20 (1930); *Refrac. Jour.*, **6** [61], 32 (1930).—Details are given of a modern tile plant using gas-fired kilns which have solved the problem of temperature control. The fire brick are set in cast-steel plates. The kiln is divided into three zones, preheating, firing, and cooling. A blower on top of the kiln at the discharge end forces cold air in, thereby setting up a positive draft which blows the hot air toward the discharge end where it is exhausted through a stack. E.P.R.

Heat balances of ceramic kilns. HOWARD H. MANSUR. *Jour. Amer. Ceram. Soc.*, **14** [2], 89–124 (1931).—The instruments, methods, and procedure for obtaining the data, the method for calculating heat balances, the description of the kilns and ware, and the efficiencies of the kilns, six in number, are given in detail. Two round down-draft kilns, one muffle, one rectangular horizontal draft, one semicontinuous, and one wholly continuous kiln were investigated. A bibliography is appended.

Waste-heat utilization of muffle kilns. E. GÜNTHER. *Sprechsaal*, **63** [51], 975 (1930).—G. discusses the possibilities for using the waste heat and bettering the heat management in muffle kilns. M.V.K.

Fuel problems. DAVID MILNE-WATSON. *Mech. World*, **88** [2287], 421–22 (1930).—The extension of the use of gas all over the world was especially commented upon at the World Power Conference at Berlin. In spite of the steady growth in the use of gas, the coal consumption of the gas industry has remained at 18,000,000 T. per annum for several years. Further work was in progress to improve coke quality by preparation of the coal before carbonizing. In three years the Gas Light and Coke Co. has spent £400,000 on coke preparation plants. Several low-temperature processes are being operated in various parts of the country, including some by the Gas Light and Coke Co. The successful treatment of coal by low temperatures is now understood. The perfecting of cracking or hydrogenation processes to improve these oils is awaited. Until this can be achieved successfully on a commercial basis there is no hopeful future for any low-temperature process principally devised to make smokeless fuel. It is more probable that the smokeless fuel of the future will be prepared from selected, prepared, and blended coals by high-temperature processes. The experiment of carbonizing coal before combustion at a power station is being continued. Several important power stations now mix coke breeze with their coal, large quantities of coke breeze being so used in London. A proper fuel policy would aim at a higher standard of freedom from ash in coal than is at present recognized, so as to avoid waste in costs of transport, maintenance of furnaces, clinker removal, ash disposal, and to prevent dust from chimneys. A proper fuel policy would see to the education of consumers in regard to the right use of fuel. E.P.R.

Graphical determination of the friction in flues. A. ALISON. *Glass*, **7** [11], 448–49 (1930).—An estimation of the frictional losses in the flues forms a preliminary stage in the design of any furnace whether operating with natural or induced draft. Numerous

formulas have been devised to enable the loss of heat due to friction to be computed. A. gives as his final equation friction in inches $W.G. = \frac{0.001894\,V^2L}{(t+460)C}$ where inches $W.G.$ = inches water gage, V = velocity of the gas in ft./sec., L = length of flue in feet, t = temperature °F, and C = hydraulic radius = area/perimeter in sq. ft. As the equation is one involving only multiplication and division, a chart having logarithmic scales can be employed. The development of the chart is given and the manner in which the chart is used is illustrated. H.W.A.

Compression and expansion of gases. SENEX. *Mech. World*, **88** [2293], 560–61 (1930).—The article presents tables and charts carefully calculated so that problems can be quickly and conveniently handled without a knowledge of the use of logarithms. The logarithmic equations have been worked out and the results so arranged that, knowing the ratio of the volumes, $\frac{V}{v}$, the ratio of the pressures, $\frac{P}{p}$, is at once given for any exponential equation between $P\,V^{1.0} = C$ and $P\,V^{1.4} = C$, thus covering all the usual cases. Intermediate values can be closely approximated by interpolation between the values in the columns of the table given or more definitely by intermediate readings on the charts. The base of the charts gives the values of R or $\frac{V}{v}$, the ratio of compression or expansion, while the vertical readings are the values of the ratio of the absolute pressures, *i.e.*, $\frac{P}{p}$. E.P.R.

Gas velocities. F. BÖSSNER. *Gas Wasserfach; Gas Age-Rec.*, **67** [1], 22 (1931).—The new method for determining gas velocities consists in making a single addition of some easily detectable gas to the gas flow. This "gas-blast method," as opposed to the troublesome inoculation method, requires only a qualitative detection of the added gas and a time measurement by a stop-watch. The added gas used was chlorine (from a cylinder) detected by formation of a blue coloring in a strong potassium iodide-starch solution or potassium iodide-starch paper, in dilutions as low as 0.005% = 0.143 mg./liter. The chlorine is detected instantly when it appears at the testing station, at such a distance that it requires 50, 100, or 200 seconds for the chlorine to travel it. The time signals for the blast and the positive reaction are given by flags. For each test, 300 g. of chlorine were blown into the pipe through two opposite $^1/_8$-in. taps; the cloud of chlorine is carried along at the same rate of travel as the gas. The volume of the pipe is to be calculated from its length and diameter. The test results show that the method is well adapted for technical gas measurements, especially in cases where the installation of an orifice or a nozzle is impossible. The method is comparable to the salt-velocity method of C. M. Allen (*Trans. A.S.M.E.*, **14** (1923)). E.J.V.

Calculating producer and waste-gas volumes. J. W. ROMIG. *Ceram. Ind.*, **16** [1], 43–49 (1931).—From the producer-gas constituents R. calculates its volumetric analysis, oxygen required for combustion, and combustion products. Knowing these things he calculates from the amount of fuel used the amount of producer gas made and then the required dimensions of the various ducts for producer gas, air, and waste gas, considering temperatures, water vapor, and inert gases present. Results can be used to (1) compare constructions of smoothly-operating units with those that give trouble; (2) work out designs on a velocity basis; (3) determine stack sizes and make comparisons; (4) compare construction costs of fuel-oil designed tanks and producer-gas tanks; and (5) develop on a rational basis, information useful in making alterations on existing tanks. W.W.M.

Natural gas and electricity as fuels. R. H. PASS. *Pottery Glass & Brass Salesman*,

42 [20], 65–66 (1930).—While many manufacturers still favor coal and oil as fuels, the majority of new installations are operated on natural gas or electricity. (1) The Sebring Pottery Co. has built a downdraft biscuit kiln in each of the four factories. (2) The Hall China Co. has just completed a new plant including a Dressler multi-burner tunnel kiln 337 ft. long. (3) Robertson & Co. has recently completed the installation of one of their Robertson junior-type tunnel kilns for glost firing. This kiln is 130 ft. long and is designed for temperatures from 2000 to 2300°F. All the above installations are operated on natural gas. E.P.R.

Measuring the temperature of flames by comparative light intensities. ANON. *Gas Age-Rec.*, **67** [1], 22 (1931).—The temperature of solids may be estimated by the eye or accurately measured by means of a thermocouple, thermometer, or optical pyrometer. For measuring flame temperature the flame is colored yellow with sodium vapor and the intensity of this light compared in a spectroscope with the light from a heated solid at known temperature. Values have been obtained for stationary flames of different mixtures of air with methane, ethane, propane, butane, isobutane, ethylene, propylene, and butylene. Maximum flame temperatures vary from 1880°C for methane to 1975°C for ethylene. The mixture of gas and air which gives maximum temperature does not correspond to that which gives maximum flame speed except for methane and Pittsburgh natural gas. Maximum calculated temperatures are 40 to 70°C higher for the saturated hydrocarbons and about 100° higher for the unsaturated hydrocarbons than the experimental values. Radiation losses account for the lower measured temperatures. E.J.V.

Composition of solid fuels. ERNST TERRES AND HERMANN KRONACHER. *Gas Wasserfach; Gas Age-Rec.*, **67** [1], 23 (1931); for abstract see *Ceram. Abs.*, **9** [12], 1081 (1930). E.J.V.

Self-ignition of coal. ANON. *Gas World; Queensland Govt. Mining Jour.*, **31** [11], 449 (1930).—Coal, which, when heated to 150° in a stream of O shows no tendency to increase the temperature, is absolutely safe in storage. That which shows a slight tendency to heat up locally, but fails to ignite inside of an hour, is safe for storing and transporting on board ship. That which ignites within one hour and below 150° is relatively dangerous. The temperature of self-ignition and the time of heating are necessary to determine relative degrees of danger. In general, the heat value of the coal is not an index to its tendency to self-ignition. Brown coals are more dangerous in this respect than soft coals. The coals tested show that the greater the O content the greater the liability to self-ignition. E.P.R.

Coal washing. WALDEMAR A. GOOSKOV. *Amer. Inst Mining & Met. Eng., Tech. Pub.*, No. 18; *Queensland Govt. Mining Jour.*, **31** [10], 431 (1930).—The experiments recorded in the paper were begun in order to find an accurate value for C, applicable to conditions in Russia in Rittinger's formula, $v = C\sqrt{D(S-1)}$. In the investigation the theories of Robert H. Richards were taken as the basis of the tests. The results confirm the conclusions of Prof. Richards. E.P.R.

Cleaning coal. R. LESSING. *Mech. World*, **88** [2283], 309–10 (1930); for abstract see *Ceram. Abs.*, **10** [1], 58 (1931). E.P.R

REPORT

Determination of slacking characteristics of coal. A. C. FIELDNER, W. A. SELVIG, AND W. H. FREDERIC. Bur. Mines, *Rept. of Invest.*, No. 3055, 24 pp. (1930).—The report describes preliminary experiments, sampling, method of tests, and check tests obtained with an accelerated laboratory test for determination of slacking characteristics of coal. It also discusses, slacking, relation of bed moisture to slacking and to slacking indices, and relation of slacking indices to rank of coal. R.A.H.

PATENTS

Gas producer. JOHN F. ROGERS. U. S. 1,784,882, Dec. 16, 1930. In a gas producer, a rotatable producer body, means for rotatably supporting the latter, means for rotating the body, a member coaxial with the lower portion of the producer body, independent means for rotatably supporting the member, means connecting the member to the producer body to be rotated thereby, an ash pan mounted on the member, the ash pan being normally rotatable with the member but so mounted on the member as to be capable of rotative movement relative thereto, acting automatically and at intervals on the ash pan to impart turning movements thereto relative to the member and producer body.

Gasifying coal, etc. CALEB DAVIES, JR. U. S. 1,784,985, Dec. 16, 1930. Apparatus for complete gasification of solid fuel, comprising a rotary water-gas generator; a carbonizer thereabove connected to receive hot water gas therefrom and supply carbonized residue thereto, the carbonizer being inclined and having a rotary mounting whereby to continuously lift and drop the fuel through the hot gas stream; a fuel preheater; and a connection between the preheater and the carbonizer.

Manufacture of combustible gas. HENRY O. LOEBELL. U. S. 1,785,519, Dec. 16, 1930. In the process of making water gas in which a gasmaking zone in a fuel bed is blasted in alternate periods of time with air and steam, the improvement which comprises introducing water into a vaporizing zone during the steam-blast period, in which zone the water is substantially instantaneously converted to steam, supplying the resulting steam to the gasmaking zone during the steam-blasting period, and automatically decreasing at a predetermined time-controlled rate the supply of water to the vaporizing zone during the steam-blasting period thereby to maintain a substantially constant excess of steam in the water gas leaving the gasmaking zone.

Ventilator. GEORGE E. BLACK. U. S. 1,785,540, Dec. 16, 1930. The combination with a ventilator provided with an eduction pipe, of a valve coöperating with the pipe to close and open the same, and a gutter below the valve open at its top and provided with side and end walls, and having a water-outlet pipe extended from one of the end walls through the eduction pipe to the outside thereof.

Removal of smoke from coke ovens. JOSEPH VAN ACKEREN. U. S. 1,785,748, Dec. 23, 1930. In coke ovens, etc., in combination, a heat-treating chamber having a wall provided with a feed opening for delivering to the chamber the material to be heat treated and having smoke or gas pockets on opposite sides of the opening that open into the chamber; and means bridging the opening for conveying smoke and gases from one pocket to the other past a stream of material entering through the feed opening.

Charging vertical retorts. JOSEPH VAN ACKEREN. U. S. 1,785,749, Dec. 23, 1930. In a vertical retort battery, etc., in combination, a larry car provided with a charging hopper adapted to discharge fuel into a retort chamber, the hopper being provided at its lower extremity with an offset discharge member provided with a valve controlling the flow of the fuel, the member being adapted to be positioned over the feed opening in the retort chamber to provide a view of the charging operation unobstructed by the body of the hopper; and an operator's platform carried by the larry car adjacent the offset discharge member substantially as specified.

Charging coke ovens. JOSEPH VAN ACKEREN. U. S. 1,785,750, Dec. 23, 1930. In combination with a coke-oven battery having side-by-side horizontal coking chambers with intermediate heating walls, an oven roof covering the tops of the coking chambers and heating walls and forming the tops of the chambers, and having a charging opening and a gas-offtake opening for each of the coking chambers, both the charging opening and the gas-offtake opening extending through the oven roof from the top to the bottom thereof and the charging opening being intermediate the ends of the oven.

Charging a retort. JOSEPH VAN ACKEREN. U. S. 1,785,751, Dec. 23, 1930. In a continuous vertical-coking apparatus, the combination with a battery of continuous vertical coking retorts, covered coal-feeding magazines mounted in the top of and individual to the several coking chambers and adapted to feed coal continuously and gradually into the tops of the chambers.

Coke retort with quenching device. JOSEPH BECKER. U. S. 1,785,760, Dec. 23, 1930. In an apparatus for discharging coke ovens, in combination, an extractor magazine having its upper portion offset from its lower portion; means for subjecting the hot coke as it descends from the upper portion to the action of a quenching liquid; means located below the upper portion for feeding the quenched coke across the magazine to and down the side of the lower portion remote from the upper portion, the means being pervious to the passage of the quenching liquid for separation of the spent liquid from the coke during the transverse passage; means located below the feeding means for collecting the separated spent liquid in the lower portion of the magazine that supports previously-quenched coke and for maintaining the separated spent liquid out of contact with the previously-quenched coke therein; and means for discharging the spent liquid from the magazine from the portion thereof that supports the previously-quenched coke.

Feed mechanism for gas producers. JOHN F. ROGERS. U. S. 1,785,789, Dec. 23, 1930. (1) In apparatus for feeding material, a valve in the line of feed, mechanism for operating the valve comprising a cam and a cam follower operatively connected with the valve, a counter-balance weight, and a second cam interconnected with the first cam and mounted to move in timed relation therewith, the second cam being operatively connected with the counter-balance weight and timed to move the counter-balance weight from high to low position and back again while the follower moves up the ascent side of the cam and down the descent side thereof. (2) In a fuel feed for gas producers, a base and a casing spaced apart vertically, a bottom member for the casing interposed between the base and the casing and normally supporting the casing, and screws associated with the base and casing outside of the bottom member for raising and supporting the casing independently of the bottom member, whereby the bottom member may be slid out of position for repair or replacement.

Drying and firing molded ware. JOHN MARTIN PILLATZKE. U. S. 1,786,364, Dec. 23, 1930. An endless firing tunnel having its upper wall provided with a plurality of smoke outlets, a smoke flue extending lengthwise of the tunnel and having its upper wall formed with a plurality of longitudinally-spaced smoke inlets, removable caps normally closing the outlets and the inlets, means for selectively connecting certain of the outlets and inlets to provide for the passage of smoke from the firing tunnel to the smoke flue through selected outlets and inlets, and means for creating drafts of air in the tunnel on opposite sides of the connected outlets and inlets, the drafts flowing longitudinally of the tunnel toward the connected outlets and inlets.

Water-gas process. T. LICHTENBERGER AND L. KAISER. Ger. 493,675; *Gas Age-Rec.*, **66** [26], 1041 (1930).—Carbon and hydrogen are brought into continuous contact with one another in a molten salt bath for continuous reaction. Superheated steam is added to the molten bath. E.J.V.

Burner. SOCIÉTÉ DES FORGES ET ACIERIES DE COMMERCY. Ger. 495,082; *Gas Age-Rec.*, **66** [26], 1041 (1930).—A cooling wall is interposed between the burner outlet and the wall of the combustion chamber. The cooling device is formed of a plate whose central opening is widened out in the direction of the combustion chamber. E.J.V.

Carbonization of fuel. JULIUS PINTSCH A.-G. Ger. 495,255; *Gas Age-Rec.*, **66** [26], 1041 (1930).—The required heat for carbonization is carried by a gaseous stream which circulates through the carbonizing ovens and through a two-chamber or multi-

chamber regenerator. The distribution of gas circulating through the carbonizing coal in opposition to the heating gases which are burned in the recuperators, is effected without the aid of baffle devices subjected to the action of high temperatures. E.J.V.

Tunnel kilns. V. LASTOVICKA. Brit. 336,171, Dec. 3, 1930. A longitudinal recess is formed in one side wall of a tunnel kiln and extends from the stack flue to a point opposite the fireplace. The lower edge of the recess is at the same level as the floors of the trucks. A drying chamber is arranged above the tunnel and a part of the heating-gases may be passed into this through a dampered roof opening. Air for cooling the goods is admitted by the end door and the undersides of the trucks are cooled by air admitted through openings near the furnace. The trucks are moved through the tunnel by a wire rope and a winch. Mica-covered inspection apertures are provided.

Gas producers. A. L. GALUSHA. Brit. 337,005, Dec. 17, 1930. Charging apparatus for gas producers comprises a feed-hopper of large size. The fuel passes by gravity to the producer through a number of vertical chutes.

Geology

Structure of danburite, $CaB_2Si_2O_8$. C. DUNBAR AND F. MACHATSCHKI. *Z. Krist.*, **76** [1–2] 133–46 (1930).—Danburite is a silicate of calcium and boron and belongs to the orthorhombic class of crystals. Each silicon atom is surrounded by four oxygen atoms. Although the ratio of the oxygen to silicon atoms in the unit cell is four to one, the unit of the structure is not a silicon tetrahedron but an Si_2O_7 group, two tetrahedral groups being linked together by a common oxygen atom which lies on a reflection plane. This accounts for seven of the eight oxygen atoms in the chemical formula. The eighth oxygen atom is placed on a reflection plane in such a way as to form a tetrahedron with oxygen atoms from three Si_2O_7 groups, and into these tetrahedra the boron atoms have been placed. There are in the structure not only a series of Si_2O_7 groups but also B_2O_7 groups. The unit cell which contains four molecules of $CaB_2Si_2O_8$ has the dimensions $a = 8.75$ Å, $b = 8.01$ Å, $c = 7.72$ Å, giving the axial ratios $a:b:c = 1:0.9154:0.8822$. V_h^{16} was adopted as the true space group. The unit cell contains 4 calcium, 8 boron, 8 silicon, and 32 oxygen atoms. G.R.S.

Bentonite. SILICA PRODUCTS CO. *Brit. Clayworker*, **39** [463], 295–99 (1930).—Bentonite is a natural hydrous silicate of alumina represented by the chemical formula $Al_2O_3 \cdot 4SiO_2 \cdot XH_2O$, and has the distinctive property of forming a highly viscous solution in the presence of not less than 10 times its weight of water. The article describes bentonite, its size in comparison with other substances, its chemical constitution compared with other silicates of alumina, how to identify it, its occurrence, origin, and methods of preparation for the market. R.A.H.

Diatomite: principal New Zealand occurrences and uses. L. I. GRANGE. *N. Z. Jour. Sci. Tech.*, **12**, 94–99 (1930).—An account is given of diatomaceous earth and its industrial applications. H.H.S.

Gallium, germanium, indium, and scandium. ALICE V. PETAR. Bur. Mines, *Information Circ.*, No. 6401, 17 pp. (1930).—The report gives the history of these four rare elements and describes their properties, occurrence, uses, and metallurgical treatment. It also notes markets and prices, lists dealers and importers, and includes a bibliography. R.A.H.

Oxidation of pyrite and sulphur as influenced by lime and magnesia. A 12-year lysimeter study. W. H. MACINTIRE, W. M. SHAW, AND J. B. YOUNG. *Soil Sci.*, **30** [6], 443–57 (1930). G.R.S.

Practical geology for brickmakers. I. JAMES STANWORTH. *Brit. Clayworker*, **39** [461], 198–200 (1930).—Clays along with sandstones, coal, and limestones belong to the group of rocks known as sedimentary or aqueous rocks. Most of them are marine deposits and because sedimentary rocks occur in fairly parallel layers or beds, they are known as stratified rocks. An examination of a sandy shore line at extreme high tide will show rounded stones called the shingle. These when followed toward the sea give place to coarse sand, then to fine sand which extends below sea level. If the line could be followed further it would give way to mud. The mud is made up of fine sands from the rocks forming the shingle and clay matter. The clay comes from the breaking down of the mineral feldspar which, in turn with mica and quartz, is an important constituent of granite. When the feldspar breaks down it is converted into china clay and the quartz and mica are set free. These substances are carried by rivers and deposited in the sea as sediments. S. shows how the sediments are changed to rock by the cementing action obtained from carbonate of lime (oyster shells) and soluble silica from diatoms into rock. They may result in conglomerates, sandstone, clays, and shales. The formation of folds are discussed as well as the geological ages. **II.** *Ibid.*, **39** [463], 284–85 (1930).—A geological map is one on which is superimposed the positions of the outcrops of the various series of beds, with their directions and angles of dip, measured downward from the horizontal; the position of faults and their displacement; and a large amount of other geological data. S. describes in detail how such maps should be read and how the knowledge gained is applied commercially. R.A.H.

Anhydrite and its possible uses. ANON. *Queensland Govt. Mining Jour.*, **31** [10], 423 (1930).—Anhydrite, the anhydrous calcium sulphate, has been considered for many years to be of little commercial value. Recent investigations have demonstrated that it is possible to use as much as 50% anhydrite with gypsum as a retarder for Portland cement. E.P.R.

Canadian feldspar plant. ANON. *Pit & Quarry*, **21** [6], 53–56 (1930).—Since 1920 most of the feldspar produced in Canada has come from the Buckingham district immediately northeast of Ottawa, Ont., in the province of Quebec. A number of mines in this vicinity produced some of the highest-grade feldspar known to the industry. These feldspars vary from pure white to cream in color and have unusually high-potash and low-soda contents. Shipments have been made principally to the mills at Rochester, N. Y., for use in the ceramic industries. This deposit is owned by O'Brien & Fowles, Ltd., and is being operated by the Feldspar Quarries, Ltd. It is known as the Derry mine and furnishes part of the feldspar for the new processing plant owned by the Canadian Flint & Spar Co. at Buckingham which went into operation early in 1930. The Derry mine was originally operated as an open quarry but is now operated underground to a depth of 190 ft. See also *Ceram. Abs.*, **10** [1], 64 (1931). E.P.R.

Geoelectric prospecting for ore. ARNALDO ZABELLI. *Queensland Govt. Mining Jour.*, **31** [10], 428–29 (1930); for abstract see *Ceram. Abs.*, **9** [12], 1090 (1930). E.P.R.

Glass sand deposit. ANON. *Nat. Glass Budget*, **46** [34], 5 (1930).—Fayette County, W. Va., is said to be adding to the list of that state's rich natural resources by the discovery of a very large deposit of silica sand that is suitable for making glass. E.P.R.

Kaolin mining in the N. W. Saxon porphyry territory. A. LAUBENHEIMER. *Ber. deut. keram. Ges.*, **11** [4], 161 (1930).—Fundamental notes about the mineralogical, geological, and genetic characteristics are given and the kaolin mining in this special territory is described. I.R.

Fluorine deposits in France. R. DELABY. *Giorn. chim. ind. applicata*, **12** [11], 561 (1930).—The rich deposits of fluorine in France are being prematurely exhausted

because quarrying is not rationalized. Fluorspar at 92% is used in the glass and ceramic industries. In the manufacture of cement, fluorine is used to lower the vitrifying temperature from 1400 to 1000°. M.V.K.

BOOK AND BULLETIN

Diatomaceous Earth. ROBERT CALVERT. Reviewed in *Chem. Met. Eng.*, **37** [12], 763 (1930); see also *Ceram. Abs.*, **10** [2], 143 (1931). G.R.S.

Geophysical Abstracts. XV. FREDERICK W. LEE. Bur. Mines, *Information Circ.*, No. 6341, 25 pp. (1930).—Current articles, books, and patents on the theory and application of geophysical methods of prospecting are reviewed. **XVI.** *Ibid.*, No. 6355, 23 pp. (1930). **XVII.** *Ibid.*, No. 6366, 29 pp. (1930). **XVIII.** *Ibid.*, No. 6393, 27 pp. (1930). **XIX.** *Ibid.*, No. 6403, 31 pp. (1930). For Part XIV see *Ceram. Abs.*, **9** [10], 879 (1930). R.A.H.

Chemistry and Physics

Silica gel as a catalyst base. ANON. *Chem. News*, **141** [3684], 324(1930).—This active adsorbent can be used over and over again in a continuous cycle of adsorption, revivification, and cooling. G.R.S.

Vapor-adsorption capacity of silica gels as affected by extent of drying before wet-heat treatment and by temperature of acid treatment and activation. HARRY N. HOLMES AND A. L. ELDER. *Jour. Phys. Chem.*, **35** [1], 82–92 (1931). G.R.S.

Mass-analytical determination of silicic acid in silicates. N. A. TANANAEFF AND A. K. BABKO. *Z. anal. Chem.*, **83** [4–5], 145–50 (1930); *Stahl Eisen*, **50** [48], 1697 (1930).—A discussion is given of (1) the conversion of silicates; (2) the change of silicic acid into fluosilicic acid and precipitating, filtering, and washing; and (3) titration of potassium silicofluoride with soda lye in the presence of calcium chloride, and the results. M.V.K.

Determining silicic acid in water. W. STEFFENS. *Chem.-Ztg.*, **54** [103], 996–97 (1930).—By comparative tests with two calorimetric methods for determining silicic acid in water, it is found that the picric acid solution has a weak color tone verging toward greenish which can be compared with the color of silico-molybdate. S. prefers picric acid to chromate solution for the comparative solution. M.V.K.

Ceramic masses represented according to their mineralogical composition and as silicates. J. WOLF. *Sprechsaal*, **63** [49], 929–31 (1930).—In a previous work (see *Ceram. Abs.*, **7** [3], 176 (1928)) W. has represented the group, clay substance-quartz-feldspar, according to mineralogical composition and as silicates. In the same manner W. represents here the groups, mullite-quartz-feldspar and alumina-quartz-feldspar. Tables and diagrams illustrate the article. M.V.K.

Barium aluminates. HEINRICH GÜNTHER. *Feuerungstechnik*, **18** [11–12], 138–39 (1930).—G. describes the production and properties of barium aluminate. It is obtained from heavy spar and bauxite, two minerals containing barium and alumina. Heavy spar and bauxite are mixed with coal and fused. Barium aluminate is a perfect softening agent for water. M.V.K.

Using filtration method in analyses, especially for analyses of Portland cement. HANS T. BUCHERER AND F. W. MEIER. *Stahl Eisen*, **50** [48], 1697 (1930).—The following steps in the process are discussed: (1) determination of calcium by precipitation with oxalic acid; (2) determination of magnesium with *o*-hydroxyquinoline; (3) separation of calcium and magnesium; (4) determination of sulphuric acid with barium chloride; (5) determination of copper with sodium sulphide; (6) determination of zinc; (7) separation of copper and zinc; (8) precipitation of manganese with sodium ammo-

nium phosphate; (9) decomposition of zinc and manganese and copper zinc manganese; (10) determination of iron with *o*-hydroxyquinoline; and (11) precipitation of silicic acid in lime silicates. The exactness of the process is pointed out. M.V.K.

Method for separation of titanium from zirconium and hafnium. A. R. POWELL AND W. R. SCHOELLER. *Analyst*, **55**, 605–12 (1930).—Ti is precipitated by tannin from a neutralized oxalate solution half-saturated with NH_4Cl. H.H.S.

New indicator for silver titration (argentometry). A. J. BERRY AND P. J. DURRANT. *Analyst*, **55**, 613–17 (1930).—Ag may be titrated in acid solution, using tartrazine as indicator. H.H.S.

Ultrafiltration as test for colloidal constituents in aqueous and nonaqueous systems. J. W. MCBAIN AND S. S. KISTLER. *Jour. Phys. Chem.*, **35** [1], 130–36 (1931); for abstract see *Ceram. Abs.*, **10** [2], 151 (1931). G.R.S.

Chemical researches on refractory materials. III. H. J. ROYEN AND H. GREWE. *Stahl Eisen*, **50** [35], 1229–30 (1930); *Refrac. Jour.*, **6** [62], 68 (1930).—Chemical researches were made on refractory materials to find a new, simple, and reliable method for investigating chromium ore blocks. Tests with synthetic solutions were first tried. Potash alum, pure iron oxide, potassium dichromate, pure calcium carbonate, and magnesium chloride were used as raw materials. As magnesium chloride is hygroscopic and the aluminium content of potash alum does not always correspond to the formula, separate solutions of these materials were prepared for the determination of the real content of magnesium oxide and alumina. These were then added to the solution containing chrome, iron, and lime. The precipitation of magnesia was followed by the cold method. Five laboratories participated in the research; the variation in the results obtained amounts to $\pm$ 0.3% magnesia content with a content of about 5 g. magnesium oxide in a liter. The determination of alumina was made by the ammonia and phosphate processes in the alum solution. The average values agree almost exactly; the variation amounted to only 0.8% alumina content with a content of about 2.5 g. Al_2O_3 in a liter. The phosphate method was used for the following investigation of the synthetic solution of a chromium ore block, with which method good results were obtained in the analyses of clay, magnesite, and dolomite. The difficulty of precipitating quantitatively the chrome and the aluminium as phosphate and of keeping iron in the solution at the same time appeared at this stage. Through the substitution of acetic acid by formic acid, iron was kept in the solution but a part of the chromium also remained in the solution. It was found that the precipitated chromium phosphate is not a neutral chromic orthophosphate, but an acid phosphate of varied composition. Another method was then used which consisted in first decomposing the sample with soda, precipitating silicic acid with hydrochloric acid and separating aluminium, iron, and chromium from the silicic acid filtrate by precipitation of the alkaline earths with ammonia. The precipitated hydroxides are dissolved in hydrochloric acid again and the chromium is titrometrically determined in a part of the solution. The iron is titrated with titanium trichloride in a second part of the solution. Afterwards, in the third part of the solution, aluminium, iron, and chromium are again precipitated with ammonia solution, heated to redness and weighed, the alumina being determined from the difference. Manganese, when it is present in chromium ore blocks, is separated with bromine from the ammoniacal filtrate of the hydroxides, added to the hydroxides, ashed, and weighed with them. Manganese is weighed on a second scale and then deducted with Fe_2O_3 and Cr_2O_3 from the sum $Al_2O_3 + Fe_2O_3 + Cr_2O_3 + Mn_3O_4$ for the calculation of alumina. Lime and magnesia are determined from the filtrate of all hydroxides precipitated. In the five laboratories the test of the method with the synthetic solution gave very good results. The method was then tried on chromium ore blocks which gave the same results. For Parts I and II see *Ceram. Abs.*, **9** [3], 230 (1930). M.V.K.

Detection of traces of fluorine in rocks. I. P. ALIMARIN. *Analyst*, **55**, 652 (1930); see also *Ceram. Abs.*, **10** [2], 150 (1931). H.H.S.

Measurements of the plasticity of clays. G. W. SCOTT BLAIR. *Jour. Phys. Chem.*, **35** [1], 374–82 (1931).—The meaning of the term plasticity is discussed, and various simple, rough tests for the plasticity of a clay are described. It is shown that when different clays are caused to flow through a capillary tube under stress at the same concentrations, the ordinary flow constants, mobility and shearing strength (or yield value), depend on the hydration capacity of the clay rather than on its plasticity. By comparing the flow of clay pastes at such low shearing stresses that the material flows as a solid plug, and arranging the concentrations so that the water envelope surrounding the plug has a constant shearing strength it is possible to get values for the critical shearing stress of the material which depend on a property very closely allied to plasticity, to which the term "flow-plasticity" has been applied. Preliminary work on the effect of electrolytes on the flow-plasticity of kaolin is described, with special reference to the Bancroft-Jenks theory of mixed peptizing and flocculating action. G.R.S.

Conception and measurement of plasticity. The c. g. s. unit and a new plastometer. E. KARRER. *Z. tech. Physik*, **11**, 326–37 (1930); see also *Ceram. Abs.*, **9** [1], 53; [5], 386 (1930). (*C.A.*)

Classification of plastics and definition of certain properties. E. KARRER. *Jour. Rheol.*, **1** [3], 290–97 (1930).—Plastics are materials that under certain conditions have a convenient and useful range of plasticity. The first step in processing the material to bring it into the plastic state is termed plasticizing, the term for the opposite process being deplasticizing. Classification of plastics is sometimes made on the basis of (1) origin and composition, as casein, cellulose, phenol plastics, clay plastics, and rubber plastics, indicating also general lines of demarkation between industries; (2) the way in which they may be plasticized, as thermoplastics (wax, glasses), chemoplastics (rubber), mechanoplastics (clay, litharge, and glycerine), chevplastics (dental amalgams) and solvoplastics (*a*) hydroplastics (clay, plasters, mortar) and (*b*) organoplastics (nitrocellulose). This classification has no sharp boundaries, but it brings out certain difficulties encountered in defining general properties of matter. Plastics bridge the gap between liquid and solid states. When some plastics in the plasticized state are caused to flow, there frequently appears some such "yield force" in the flow equation. This yield value is a good measure of "solidness" or "solidity." Many properties of plastics are either intermediate or are extreme when compared with ordinary solids and liquids. Elasticity or "elasticness" is another quality commonly talked of, which is surrounded by considerable ambiguity. To be elastic connotes more in respect to resumption of shape than reference to forces necessary to change shape. G.R.S.

Analysis of lime in samples fused with sodium carbonate. W. P. ECKDAHL. *Rock Prod.*, **33** [26], 67 (1930).—In precipitating calcium oxalate in the presence of soda salts, sodium oxalate is incorporated in the colloidal precipitate and can be removed only with great difficulty. The effect is more noticeable in high calcium contents and more so in volumetric than in gravimetric determination. To purify the precipitated calcium oxalate, filter, wash five or six times with warm water, ignite to the oxide, redissolve in 1:1 HCl, make ammoniacal, and precipitate the lime as carbonate with ammonium carbonate. Filter and wash with ammonium carbonate water. Dissolve the precipitate in HCl and precipitate the calcium oxalate in the usual manner for gravimetric or volumetric determination. W.W.M.

Chemical activation of quartz surfaces. P. G. NUTTING. *Science*, **72** [1862], 243–44 (1930).—Certain classes of filters operate not by straining but by selective adsorption on exposed surfaces. A laboratory study showed that the activation of crystalline quartz is neither difficult nor complicated. The plan was to attack the surface of

the quartz with a strong alkali, forming a layer of alkali silicate over the surface, replace the base by hydrogen, then drive off the H and OH by heating, leaving open bonds. Fused KOH (350°C) worked well. Boiling in HCl followed by thorough washing and drying completed the activation. The object of the chemical treatment is to open up the SiO_2 bonds over the surface. Quartz or sea sand, given a brief bath of HF, was found to be activated just as well as by the alkali and HCl treatment. Activated surfaces of pure quartz are excellent filters per unit area and their filtering action is purely chemical. G.R.S.

X-ray fingers feel out the atomic structure of matter. WILLIAM BRAGG. *Sci. Amer.*, **143** [6], 434–35 (1930).—A brief outline is given of the importance of the microscope in metallurgy, textile industries, and agriculture. The limit of the microscope depends upon the nature of light itself. An immense field is opened by the use of X-rays. The atomic structure of substances such as copper and diamonds is described. The distances between the atoms vary about an average of the forty-millionth of an inch. The method in which X-rays are employed to examine the crystalline structure of any body is considered. G.R.S.

Organic compounds as electrolytes and their effect on the properties of clay slip and on the life of plaster molds. C. W. PARMELEE AND C. G. HARMAN. *Jour. Amer. Ceram. Soc.*, **14** [2], 139–47 (1931).—An attempt was made to indicate the possibility of using organic compounds as casting electrolytes, and to ascertain their effect upon the durability of plaster molds. The data presented point out the fact that ethylamine, piperidine, or tetramethylammoniumhydroxide may be used as casting electrolytes and that they attack molds to a lesser degree than do sodium carbonate and sodium silicate. Some data are presented which compare viscosity with surface tension.

Mechanism of the coagulation of sols by electrolytes. I. Ferric oxide sol. H. B. WEISER. *Jour. Phys. Chem.*, **35** [1], 1–26 (1931).—A procedure is described for accurate potentiometric determination of the change in chloride concentration on adding electrolytes stepwise to hydrous oxide sols containing a slight excess of HCl or $FeCl_3$ as stabilizing electrolyte. The relative merits of the proposed adsorption mechanism of the coagulation process and the solubility theory of Pauli are discussed. G.R.S.

Ion interchanges in aluminium oxychloride hydrosols. A. W. THOMAS AND T. H. WHITEHEAD. *Jour. Phys. Chem.*, **35** [1], 27–47 (1931).—The authors found that (1) aging of aluminium oxychloride sols, prepared as described in this paper at 20°C, resulted in decreased hydrogen-ion activity. (2) Heating of such sols resulted in increased hydrogen ion activity and subsequent cooling did not immediately decrease it. (3) The addition of neutral salts to the sols produced a decrease in the hydrogen-ion activity. (4) An anion order was established, *i.e.*, oxalate, acetate, sulphate, halides, and nitrate which is identical to the anion penetration order of Stiasny. (5) Explanations for these results and a suggestion for the constitution of such sols have been offered on the basis of the Werner theory and its extension by Bjerrum and Stiasny. G.R.S.

Some unusual properties of colloidal dispersions. R. V. WILLIAMSON. *Jour. Phys. Chem.*, **35** [1], 354–59 (1931).—A number of experiments are described to show the marked changes in the plastic and elastic properties of dispersions which may be produced simply by changes in temperature or in the magnitude and rate of application of stresses. The experiments may be useful to the manufacturer of colloidal materials because they illustrate some of the unexpected results that may occur from simple changes in the physical environment of the materials. They should also be useful to those interested in the fundamental study of structure in colloidal dispersions because they furnish a number of facts which must be explained by any comprehensive theory of colloidal structure. G.R.S.

Equilibrium phenomena in coagulation of colloids. E. F. BURTON AND MAY AN-

NETTS. *Jour. Phys. Chem.*, **35** [1], 48–72 (1931).—The blue gelatinous precipitate obtained by the action of an alkali with a cupric salt is variously described as cupric hydroxide and hydrous cupric oxide. The literature relative to the preparation and properties of this substance is reviewed with particular reference to the conditions which retard or accelerate its change to black cupric oxide. G.R.S.

Transmitted structural blue in microscopic objects. C. W. MASON. *Jour. Phys. Chem.*, **35** [1], 73–81 (1931).—On the basis of direct qualitative experimental evidence, rather than computations which of necessity would demand even more assumptions, M. concludes that (1) uniformly-sized particles of structures finer than about 0.4μ scatter light inversely as λ^4, and are not resolvable with axial illumination. They exhibit Tyndall blue and transmit yellow or orange, even with relatively diffuse illuminations. (2) Uniformly-sized particles or structures between about 0.4μ and 0.7μ scatter red light and diffract blue in maxima at such angles as to be resolvable with blue light and axial illumination. If they are of bold outlines or surrounded by a medium of widely different refractive index, they exhibit transmitted blue and scattered yellow or orange even with slightly diffuse illumination. (3) Uniformly-sized particles or structures coarser than about 0.7μ diffract all wave lengths, the red more than the blue. If of good contrast, they exhibit transmitted blue, provided the numerical aperture of the objective is such as to include only the blue end of the diffracted spectra obtained with a narrow axial illuminating cone. (4) Transmitted blue, which is lost in diffuse light, is apparent to the naked eye with specimens coarser than 0.4μ. It is due to the greater deviation of red than blue, either by scattering or by diffraction. (5) Transmitted blue, visible to the naked eye, exhibited by suspensions of fine particles, is probably explained by the above reasoning. G.R.S.

Electrophoresis and the diffuse ionic layer. MELVIN MOONEY. *Jour. Phys. Chem.*, **35** [1], 331–44 (1931).—The theory of the diffuse ionic layer and its influence on the electrophoresis of a sphere is outlined and a theoretical formula for the limiting slope of the mobility-curvature curve is given. Experimental data are reported which are in rough agreement with the theory as applied to dilute aqueous solutions. In concentrated solutions there is definite disagreement in some cases. Formulas are given for surface charge and surface conductivity. The latter formula does not agree with measured values. Various anomalous effects in cataphoresis suggest the existence of a plastic adsorbed layer which seems to have a profound effect on the electrokinetic potential in concentrated acid and neutral solutions. It is pointed out that the validity of the Debye-Hückel cataphoresis formula is limited to conditions in which the colloidal particle is much smaller than its diffuse ionic layer. G.R.S.

Determining the temperature prevailing at the solid-liquid boundary during crystallization from undercooled melts. HERBERT POLLATSCHEK. *Z. physik. Chem.* [Abt. A], **142** [4], 289–300 (1930).—A method is described for the determination by thermoelectrical methods of the temperature relations at the boundary solid-liquid. The experiments were made on salol and salol glasses and showed that the temperature of melting of the substance is not reached at the boundary of the solid-liquid phase during the cooling from undercooled melts. This contradicts the evidence previously obtained by G. Tammann (see *Ceram. Abs.*, **9** [10], 831; [11], 982 (1930)). The article contains a discussion of the mathematical-theoretical principles underlying the method and the evaluation of the results. L.T.B.

Method for converting alkali sulphate into alkali chloride in silicate analyses. WERNER MYLIUS. *Sprechsaal*, **63** [51], 972–75 (1930).—M. discusses the disadvantages of different methods for converting the alkali of silicates into chlorides, and gives the results of his own investigations which are as follows: (1) A new method for converting alkali sulphates into chlorides can be used in silicate analyses instead of the complicated

conversion by the perchlorate method with barium chloride for the separate quantitative determination of potash and soda. The powdered neutral sulphate is converted into alkali chloride by a double evaporation to dryness with hydrazindichloride, N_2H_42HCl. (2) The method with quantities of sulphate which in the weight of a silicate of 0.5000 g. correspond to about 5 to 25% alkali oxide content, approximated the theoretical values. The remaining content of SO_3 amounted to only 0.1 mg. or less in the chloride obtained in this way. (3) The method can be performed rapidly. The conversion of 0.1694 g. Na_2SO_4 (corresponding to 14.78% Na_2O in 0.5000 g. silicate) into chloride took 85 minutes including 2 weighings for determining the constant weight of the sodium chloride obtained. (4) It is pointed out that in determining the alkalis in silicates, the alkali chloride is obtained less quickly by the method of Lawrence and Smith, than by the following procedure: Decomposition with hydrofluoric acid-sulphuric acid, precipitation of disturbing bases with α-hydroxyquinoline, isolation of alkalis as sulphates according to the Robitschek method, and conversion of alkali sulphate into chloride by evaporating to dryness with hydrazindichlorhydrate in the manner described. M.V.K.

Color reaction of Japanese acid clay toward hydrochloride of malachite green leuco base. N. KAMEYAMA AND S. OKA. *Chem. News*, **141** [3682], 297–98 (1930).—The authors conclude that the oxidizing property of the acid clay toward acid reagents is due to the manganese dioxide contained in the brownish-black particles in it. G.R.S.

Viscosity of blast-furnace slags. RICHARD S. MCCAFFERY. *Mining & Met.*, **12** [289], 22 (1931).—A detailed description of the apparatus and method for determining the relations between the viscosity, temperature, and composition of the system silica-alumina-lime-magnesia, within which the blast-furnace slags are found, is given. Typical test log and data sheets illustrate the method of calculation. The reproducibility of results is emphasized and compared with results of other workers. Magnesia is shown to have more influence than lime in reducing slag viscosity. For detailed use in blast-furnace operation or in other investigations, results are summarized in numerous diagrams and tables. A method is given by which any particular slag can be located on the diagrams and the effect of changes of composition and temperature can be determined readily and used to secure greater regularity of blast-furnace operation.

E.J.V.

Determination of zinc in refractory bodies and slags. EDWARD E. MARBAKER. *Jour. Amer. Ceram. Soc.*, **14** [2], 162–75 (1931).—An earlier published method for the determination of zinc in discarded retorts and other refractory bodies was found to be accurate but too tedious for commercial work. An effort was made to develop a shorter method. It was found that the ordinary ammonia-ammonium chloride separation of iron from zinc is not accurate in the presence of relatively large amounts of alumina. A rapid method involving the separation of zinc from iron and alumina under conditions involved in the analysis of refractory bodies was developed. The method consists in precipitating iron and zinc sulphides from an ammoniacal solution containing the three ions in which the alumina is held in solution by the presence of citric acid. Methods for the determination of zinc are discussed and reasons given for the adoption of the gravimetric method involving the precipitation of zinc sulphide from a faintly acid solution.

Effect of fluorspar on physical properties of lime-silica slags. ANON. *Queensland Govt. Mining Jour.*, **31** [9], 381 (1930); for abstract see *Ceram. Abs.*, **10** [2], 146 (1931).

E.P.R.

Simple method of rational analysis on the basis of the hydroxyquinoline acetate method. F. W. MEIER. *Sprechsaal*, **63** [50], 953–54 (1930).—M. discusses different methods of rational analyses of clays, kaolins, sand, and feldspar and points out their complexity and frequent inexactitude. A new method for the determination of alumin-

ium, kaolin, or kaolin-quartz-feldspar mixtures with a small iron content, and clays with a high iron content is given which greatly shortens the time of determination. The method depends on the common precipitation of iron and aluminium in acetic acid in the presence of sodium acetate with an excess of the "oxinacetate" solution and bromometric titration of the "oxin" surplus. In one part of the weak acetic acid solution containing sodium acetate, iron and aluminium are jointly precipitated by a precise quantity of oxin in excess, and the surplus bromometrically determined. In the aliquot part, the iron is determined iodometrically or by another method. By converting the iron values found into cubic centimeters oxinacetate solution, the number of cubic centimeters which corresponds to the quantity of aluminium is ascertained by subtraction and from it the pure alumina content is determined. The surplus in oxin is ascertained by the bromometric method of W. Manchot and F. Oberhauser (*Z. anorg. allgem. Chem.*, **130,** 161 (1923)) which shows the final point of the titration through the change of an indicator by uncombined bromine. The preparation of the oxinacetate solution and the bromine solution for the bromometric determination of the oxin in surplus, the method of working, and examples for calculating the aluminium determination by joint precipitation are described. Owing to the great sensitiveness of this method it is possible to determine small quantities of aluminium in silicates. The certainty and reliability of the method is guaranteed even when using very dilute solutions so that with proportionately small quantities of oxin a series of determinations can be made. M.V.K.

Freezing point of nickel as a fixed point on the international temperature scale. H. T. WENSEL AND WM. F. ROESER. Bur. Stand., *Jour. Research*, **5** [6], 1309–18 (1930).—The importance of the nickel point in optical pyrometry is discussed. The freezing point of nickel was found to be 1455°C on the International Temperature Scale with an uncertainty of 1°. The chemical analysis indicated the purity of the nickel as 99.94%. R.A.H.

Measuring strains between ceramic glazes and bodies. ANON. *Ceram. Age*, **16** [2], 86–88 (1930); see also *Ceram. Abs.*, **9** [10], 856 (1930). A.E.R.W.

Mullite formations in ceramic bodies. L. SOLODOVNIKOVA. *Trans. Ceram. Research Inst.* [U.S.S.R.], **25,** 11 pp. (1930).—By microscopical investigations of different ceramic bodies, S. found the presence of a crystal formation of mullite, the size and quantity of which depend on the temperature, length of firing time, and porosity. The investigation of a porcelain pipe of a thermoelement subjected to a temperature of 1600° for 16 hr. showed that the porcelain body changed into a vitrified ground mass with mullite crystals similar to needles. Their prism angle was 89°26′; $n_g = 1.655$ and $n_p = 1.643$; double refraction 0.125; $2V = +49°30'$. An old glassmelting pot showed crystalline mullite needles with a refraction of light of 1.64 to 1.65 and a double refraction of about 0.012. Several kaolin cones, grog bodies, and mixtures of kaolin and alumina were also investigated and their mullite formation and properties studied. M.V.K.

Determination of calcium and magnesium in dolomitic limestone with sugar solution. A. C. SHEAD AND B. J. HEINRICH., *Ind. Eng. Chem.* [Anal. Ed.], **2** [4], 388–89 (1930); *Stahl Eisen*, **50** [48], 1697 (1930).—The authors describe the method, its difficulties, and the results obtained. M.V.K.

Influence of water content of clays on their properties in drying and firing. V. P. ZOUBTSCHANINOV AND D. I. SMIRNOV. *Trans. Ceram. Research Inst.* [U.S.S.R], **24,** 35 pp. (1930).—The authors investigated (1) shrinkage and porosity of clays after drying to 110°; (2) shrinkage and porosity of bodies after firing to porous and vitrified states; and (3) shrinkage and loss in weight at different periods of drying and changes taking place during these processes. Satisfactory results were obtained in measuring the volume deformation, loss in weight, and volume porosity of samples while drying,

and after firing to Seger cones 0.10 (900°) and 10 (1300°). Three periods can be distinguished during drying: In the first, shrinkage and loss of water proceed with constant velocity, shrinkage in volume of the body remaining equal to the volume of the water evaporated. In the second period, the decrease in water proceeds with changing velocity while the volume of clay remains constant. When drying in the air a certain part of the water remains in clay. During the third period, the remaining water is removed by heating to 110°. Three kinds of water are present in a plastic paste: (1) Water of shrinkage which, when it evaporates, causes the shrinkage of the clay. (2) Water of pores which is removed after the shrinkage ceases. (3) Hygroscopic water removed by heating. The quantity of shrinkage water depends on the initial water content, but the quantities of the pore and hygroscopic water do not. The extent of shrinkage depends only on the quantity of the shrinkage water. The relation between the amount of shrinkage and the amount of water of pores is a characteristic property of clays. The relative content of water of porosity in kaolins is larger than in clays, although kaolin is more porous than clays. The degree of water content in the paste has no influence on the change of the density and size of the clay piece during firing.

M.V.K.

Drying of clay and clay mixtures. II. V. BODIN AND P. GAILLARD. *Brit. Clayworker*, **39** [460], 164–68 (1930); for abstract see *Ceram. Abs.*, **9** [8], 678 (1930).

R.A.H.

Discovery of boric acid in glaze of Roman pottery. R. NASINI. *Chem.-Ztg.*, **54** [102], 985 (1930).—N describes his investigations on Roman pottery made from terra sigillata of a beautiful coral red and having a very thin glaze of exceptional luster. It was discovered that the glaze covering the ware contained boric acid which was used as regular ingredient of the glaze. The ware was found near Arezzo and dates from the first century B.C. and A.D. M.V.K.

BOOKS

Chemistry Notebook. J. MORRIS. Methuen and Co., Ltd., London, 1930. *Mech. World*, **88** [2293], 559 (1930).—After explaining the chief laws and theories of chemistry, later sections refer to acids, bases, alkalis and salts, oxygen and its compounds, and ozone. Subsequently well-prepared notes and data are given on hydrogen, nitrogen, carbon, sulphur, and their compounds, in addition to the halogens, phosphorus and its compounds, the alkali metals, metals and their compounds, boron, and silicon. Finally, this commendable little book closes with a short chapter on the essentials of volumetric analysis. E.P.R.

Mining Physics and Chemistry. J. W. WHITAKER. With an introduction by W. H. MCMILLAN. 2nd ed., xii + 268 pp., 94 figs. Edward Arnold & Co., London. Price 9s. Reviewed in *Colliery Guard.*, **141** [3649], 2075 (1930).—This is a reprint rather than a revised edition, and the book remains an admirable textbook covering a wide ground with an excellent regard for conciseness and clarity. E.J.V.

Determination of Hydrogen Ions. W. MANSFIELD CLARK. Williams & Wilkins Co., Baltimore, 1928. 3rd ed. 717 pp. $6.50. *Jour. West. Soc. Eng.*, **35** [5], 405 (1930).—This edition, which is completely rewritten, has been considerably enlarged, both from the experimental and theoretical sides. From the theoretical side, new chapters have been added on changes of free energy, temperature coefficients, the theory of Debye and Hückel, alternate methods of formulating acid-base equilibria, elementary theory of titration, and nonaqueous solutions. From the experimental standpoint the expansion will be noticed in the treatment of the optical aspects, metal-oxide and glass electrodes, and in the chapter on applications. This reference book will be of constant use to everyone who is determining hydrogen-ion concentrations. It contains an extensive indexed bibliography on applications. W.W.M.

Experimental Mechanics of Materials. H. CARRINGTON. Isaac Pitman and Sons, Ltd., London, 1930. *Mech. World*, **88** [2288], 444 (1930).—Along with a detailed description of 29 experiments relating to the general study of the strength of materials, this well-arranged volume contains much information that is of daily service to those whose work involves tests according to the B.E.S.A. specifications. The first quarter of this treatment is devoted to a full description of the methods of testing of standard types of machines. The subject of hardness is represented by descriptions of the Brinell and scleroscope methods. E.P.R.

Matter and Radiation. J. BUCKINGHAM. Oxford Univ. Press, London, 1930. *Mech. World*, **88** [2294], 588 (1930).—This book is devoted to a study of methods used in detecting infra-red rays, and the use of these rays in industry. The subject is introduced in its various phases in the first three chapters, which contain a clearly written and easily understood treatment of electric waves, atoms, and molecules, the structure of atoms, and the production of radiation. The related theories are explained and the various methods of detecting infra-red rays are described by a gradually built-up system of ideas. E.P.R.

Minerals: Study, Mechanical Preparation, and Selling. (Les Minerals: Étude, Preparation Mécanique, Marché.) Ch. BERTHELOT AND J. ORCEL. Bailliere & Fils, Paris, 1930. 544 pp., illustrated. Price 105 F. Reviewed in *Mining & Met.*, **12** [289], 16–18 (1931).—The first section of the book deals with microscopic examination of metallic minerals and is followed by one on its significance in geology and in ore dressing. The next section deals with qualitative analysis of minerals, study of mineral powders, and spectrographic methods. Two brief sections take up examples of mineral deposits and are followed by a 100-page discussion of marketing of minerals and metals. Sections on mineral dressing, flotation, and concentration plants conclude the volume. E.J.V.

General

Classification of ceramic ware. C. F. BONINI. *Ind. Silicati*, **8** [9], 17–18; [10], 16–18; [11], 13–15 (1930).—Ceramic ware is classified here according to the kind of body and according to the chemical composition of the glaze used: The first division is made between the unglazed or simple ceramic products which are polished or finished by mechanical means, and the glazed or compound ceramic ware. The first class includes (1) colored porous bodies: natural terra cotta, vases, statues; (2) white porous bodies: biscuit of earthenware; (3) colored dense masses: natural unglazed stoneware; and (4) white dense masses: biscuit of porcelain. The second class includes (1) colored porous bodies; (*A*) terra cottas with silico-alkaline glaze to which belong archaic painted terra cottas, the black- and red-figured Greek terra cotta, and the "arretine" terra cotta; (*B*) terra cottas with transparent lead glaze (*a*) on the natural ground (glazed terra cottas), (*b*) on a white clay ground (mezze or half majolica), and (*c*) on a ground enameled with an opaque glaze (majolica); (*C*) terra cottas coated with an opaque tin glaze or enamel having (*a*) colored enamels in the paste (highly-fired faience), (*b*) decorations on the raw enamel (highly-fired faience), and (*c*) having decorations on the fired enamel (low-fired faience). (2) White porous pastes: (*A*) earthenware with hard transparent lead glaze (high-clay white ware); (*B*) earthenware with borax glaze (calcareous or fine English white ware); (*C*) earthenware with feldspar glaze (iron stone). (3) Dense opaque colored pastes: (*A*) Ordinary stoneware with alkaline glaze; (*B*) ordinary stoneware with crystalline lead glaze; and (*C*) stoneware with opaque tin enamel glaze (stoneware of China and Japan). (4) Dense opaque white bodies: (*A*) fine stoneware with lead glaze (German ware); (*B*) fine stoneware with borax glaze (English

ware); and (*C*) fine stoneware with feldspar glaze (fine English and French ware). (5) Dense glassy translucent body: (*A*) delicate porcelain with alkaline glaze (Persian); (*B*) porcelain with lead glaze (Italian porcelain and old Sèvres); (*C*) porcelain with tin glaze (French and Chantilly porcelain); and (*D*) porcelain with borax glaze (English and Tourney porcelain). (6) Dense translucent kaolin body: (*A*) hard porcelain with lead glaze (old Chinese); (*B*) hard porcelain with tin glaze (Chinese and Japanese); (*C*) hard porcelain with borax glaze (Palissy type of Sèvres); (*D*) hard porcelain with feldspar glaze (hard porcelain of China, Japan, Germany, France, and Doccia, Capodimonte, Venice, and Turin in Italy); (*E*) hard porcelain with feldspar glaze (magnesium porcelain of Vinovo). M.V.K.

Influence of firing temperature on ceramic bodies. JOSEPH MATĚJKA AND ALEXANDER NIKITIN. *Repts. Czechoslo. Ceram. Soc.*, **6**, 3 (1929); *Keramos*, **9** [23], 892–93 (1930); *Sprechsaal*, **63** [48], 915 (1930).—Researches to determine the influence of the height of the firing temperature on various technologically important properties of ceramic bodies were made on five different earths, *i.e.*, three kinds of clays (plastic, medium plastic, and very thin clays), one kind of marl, and one kind of refractory clay. Three other kinds of earths with lime lumps and admixtures of limestone were used to determine the injurious effects of lime lumps. (1) It was found that the height of the firing temperature has a marked influence on the coloring of the bodies, and (2) on the appearance of ware. (3) Certain regularities are found in the shrinkage of bodies during firing: . On increasing the temperature from 500 to 600 °C, a small increase of volume takes place in clays containing a certain quantity of sand admixtures. On raising the temperature from 600 to 700 °C, a small shrinkage takes place; with further increase of temperature, an increase in volume appears which reaches its maximum at approximately 800 °C. These two increases in volume of the body are caused by the changes of quartz modifications during firing. A constant shrinkage of bodies follows, first only gradually, but more rapidly at higher temperatures (over 1050°). (4) The specific weight changes also with the firing temperature. A definite relationship was determined between the specific weight and shrinkage. (5) The capability of water absorption does not change perceptibly between 600 °C and 1000 °C. The capability of water absorption falls perceptibly and suddenly on firing to 1050°; a considerable fall occurs after firing to 1100°, and an even greater at 1150° C. (6) The capability of increasing capillarity changes considerably with the height of temperature. The fact that bodies fired at low temperatures show the smallest capillarity is interesting. The capillarity increases gradually, then more rapidly, and between 900° and 1050° it reaches the highest values. At higher temperatures it again decreases, and at temperatures where the bodies become dense it reaches a minimum. (7) The permeability to water of the bodies greatly depends on the temperature of firing. It was found that bodies fired at low temperatures are impermeable; this holds good up to 800 to 850°. On increasing the firing temperature to 900°, the permeability suddenly increases, and according to the kind of earth, reaches a maximum between 900 to 1100 °C. With a further increase in temperature it decreases; the easily fusible earths, suddenly, the difficultly fusible earths, more slowly. (8) Roof tile fired to different temperatures were tested for their water permeability, warping, and stability against frost. The resistance to warping moderately increases with temperatures up to about 1000°; a considerable increase was found after firing to 1100°. All roof tile tested including those fired at low temperatures, showed stability to frost. (9) With rising temperature, the resistance to pressure increases moderately at first; later, at the temperatures where the bodies become very dense, the solidity increases rapidly. In general, the more densely ceramic bodies are fired, the greater is their resistance to pressure. (10) The resistance to strokes increases with the increase of temperature and attains its maximum at about 800 °C after which

it again decreases. Its minimum lies between 900°C and 950°C, after which it again increases with a maximum at 1150°. (11) If the ware contains lime or lime magnesium compounds which tend to form efflorescences, this tendency is strongest at low temperatures (up to 850°). These formations can be limited and sometimes even prevented by a corresponding increase of the firing temperature. (12) The injurious effects of lime lumps are especially great in bodies fired between 800° and 1000°. In bodies fired to 750° and 1100°, lime lumps have almost no influence. The injurious effects of lime lumps can be greatly lowered in practice by pulverizing the raw materials, immersing the freshly-fired ware in water, and increasing the firing temperature. M.V.K.

Relative value of various kaolins, filter candles, and filter papers in determination of insolubles in tannin extracts. E. STIASNY. *Jour. Amer. Leather Chem. Assn.*, **25**, 460–86 (1930).—The International Liaison Committee of Leather Chemists reports on comparative determinations of insolubles in tanning extracts and shows that concordant results can only be expected through the use of uniform filter materials. Sedimentation methods are not subject to these limitations. H.H.S.

Further study of paper-coating minerals and adhesives. MERLE B. SHAW, G. W. BICKING, AND M. J. O'LEARY. Bur. Stand., *Jour. Research*, **5** [6], 1189–1203 (1930).—Paper-coating materials recently studied have included four different clays, two foreign and two domestic, and also one commercial compound of diatomaceous earth. The publication includes chemical analyses, color measurements, settling data for the minerals used, description of the coating procedure, and various measurements on the finished coated papers. R.A.H.

Sodium silicate inhibits corrosion. ANON. *Sci. Amer.*, **143** [6], 478–79 (1930).—Additions of less than 0.5% of sodium silicate to shaving soap will stop the corrosive action of the soap on collapsible aluminum tubes. Another inhibiting effect of sodium silicate is its power to impart resistance to acid corrosion to such materials as Portland cement or ordinary red brick. The surface is coated with a dilute solution of sodium silicate which penetrates the pores and results in increased resistance to corrosion, abrasion, and penetration of oil and water. G.R.S.

Performance of modern steam-generating units. C. F. HIRSHFELD AND G. U. MORAN. *Trans. A.S.M.E.*, **52** [27], 265–93 (1930).—There has been much speculation during the past as to those factors which seem to be most responsible for steam-generating unit outage. Some have held that the outage increases directly with the severity of use. Others contend that the method of burning the fuel has a definite bearing on reliability. Others have set different values for unit reliability on different kinds of fuel. As the probable availability of units operating under certain conditions is a matter of utmost importance to the power-station designer and owner, it was thought that a complete and thorough study of the facts obtaining in the power-generating industry would be of great value. The study was made along the same general lines as the steam-turbine investigation made by the Prime Movers Committee of the N.E.L.A. The methods used in collecting information were as nearly identical as circumstances and the character of the units studied would permit. Daily operation logs were filled out for the period of one year by the operators of some two hundred boilers scattered about the country in sixty-odd stations. The data resulting were compiled by one group of men in such a manner that the results might be readily compared. The units have been arranged in groups or classes according to methods of fuel burning and the working steam pressures, and then numbered in order according to their average rates of evaporation. With the data arranged in such a manner it has been possible to arrive at some rather definite conclusions. E.P.R.

Heat-balance test of steam-generating equipment. B. J. CROSS. *Trans. A.S.M.E.*, **52** [27], 255–64 (1930).—The efficiency of any energy-converting apparatus is deter-

mined by a division of the energy output by the energy input. In the case of boiler and furnace this is attained by weighing the coal or other fuel and weighing the water evaporated. The efficiency as determined by the heat-balance method should have equal value with an efficiency as obtained by the test of weighing the coal and water. E.P.R.

Power and heat in the industrial plant. R. J. S. PIGOTT. *Trans. A.S.M.E.*, **52** [27], 331–37 (1930).—For most industrial plants the cost of power, and often of heat, has been a very small percentage of the total production cost, and consequently consideration of power cost has been subordinated to the larger savings obtainable in the production process. General aspect of the problems involved, power and steam heat relations, and examples of industrial installation are discussed. E.P.R.

Pulverized-fuel firing. ANON. *Mech. World*, **88** [2284], 334 (1930).—The problem of catching all the fine dust that goes up the chimneys in pulverized-fuel installations is still unsolved. In the installation at the Hams Hall power house, Birmingham, it is claimed that by placing two cyclone dust catchers in series, over 70% of the fine dust is caught, and that the remaining 30% is of such fine texture that it cannot be regarded seriously from the nuisance point of view. E.P.R.

Use of oil fuel for steam generation. J. S. GANDER. *Mech. World*, **88** [2284], 335–36 (1930).—Comparing the prices of coal and oil fuel today, we find that the latter costs per ton about three times as much as coal of good quality. Of the many methods of burning oil fuel the principal are (1) the steam with oil system, (2) the compressed air with oil system, and (3) the pressure-jet system. E.P.R.

Economics of heat transfer. W. J. WOHLENBERG. *Trans. A.S.M.E.*, **52** [27], 351–56 (1930).—It is shown how to evaluate ideal proportions for the heat-absorbing surface of a steam generator. E.P.R.

Ash from powdered coal. ANON. *Queensland Govt. Mining Jour.*, **31** [9], 366 (1930).—The removal of ash from powdered-coal furnaces is frequently a source of difficulty because of its tendency to melt in the flame and accumulate in solid masses in the ash pit. Two large power plants which burn coal having easily-fusible ash, have within the past two years, made trials of the removal of ash as molten slag. This consists in the installation of a hearth in the bottom of the furnace where the ash collects, melts, and is tapped off at intervals. The ability to predict whether this method can be successfully used in a furnace of a given construction when burning a given coal will depend on the ability to predict whether the ash deposited in the furnace will be sufficiently fluid at the temperature obtained in the slag bed. E.P.R.

Design of boiler plants. FRANK S. CLARK. *Trans. A.S.M.E.*, **52** [27], 243–47 (1930).—This paper treats the various factors that enter into the design of boiler plants, their effect on investment costs and on operating characteristics. It traces the development of the boiler plant from a number of small units operated at moderate capacities to the present plant of a few large units run at high rates of evaporation. Further, it discusses the proportioning of heat-absorbing surfaces between boiler, economizer, and air preheater to obtain the most economic result at minimum cost, and also the effect on operation of large units run at high capacity, and in turn their effect on labor and maintenance cost. E.P.R.

Embrittlement in steam boilers. FREDERICK G. STRAUB. *Trans. A.S.M.E.*, **52** [27], 339–45 (1930).—S. discusses briefly the cause of the recent boiler explosion at Crossett, Ark., attributing the failure to embrittlement produced as a result of using soda-ash treatment on a water too low in sulphate content. Other instances of cracking of seams in steam boilers are also described. Emphasis is placed upon the regular inspection of leaky seams in steam boilers, particularly when the boiler water does not meet the A.S.M.E. recommendations. E.P.R.

New use for fine clay. ANON. *Brit. Clayworker*, **39** [461], 211 (1930).—The increasing demand for emulsified asphalt and bitumen for roads, as a paint for waterproofing paper to produce a leathery finish, etc., has led to many attempts to prepare emulsions which will remain stable not only while stored, but when actually applied. Among the various stabilizing agents, fine clays appear to be specially suitable. Bentonite has been used with great success. The emulsions are made by allowing a thin stream of molten asphalt or bitumen to flow into a suspension of the clay in water, and agitating continuously by means of mechanically-operated paddles. The clay slip must be very carefully adjusted to be as near to its isoelectric point as possible, for an acid slip will be corrosive and an alkaline one will not wet the particles of asphalt properly. R.A.H.

Prospecting for clay. ANON. *Brit. Clayworker*, **39** [461], 201 (1930).—The care required is particularized. R.A.H.

Progress in clay products. ANON. *Brick Clay Rec.*, **77** [14], 765–71 (1930).—The effect of competition is reflected in the progress made in clay products. Clay products are establishing a reputation for color and special shapes. The industry now lays claim to possessing the most versatile building units available: (1) units which are structurally sound and capable of decorative treatment, (2) colored units, and (3) units which will depict whatever architectural effects may be demanded. There is advancement made in color, the recent popularity in glazes, the work done with special shapes, the study directed toward lightweight products, and the investigations for new applications to be included in a review of the progress made in the development of clay products. Each is discussed to some extent. Illustrated. E.J.V.

Clay products industry. ANON. *Brick Clay Rec.*, **77** [14], 776–81 (1930).—A collection of letters from leaders in the clay products industry expressing their opinions on the future of the industry and business in general is reprinted. E.J.V.

Development of quarrying explosives. ANON. *Pit & Quarry*, **21** [3], 57 (1930).—The major trend of explosives development in recent years has been toward a greater differentiation, with the idea of giving consumers explosives that would be especially adapted to each of the various kinds of material from hard rock to shale and clay, and to the various methods of drilling, loading, and crushing in use. E.P.R.

Progress cost. EDITORIAL. *Bull. Amer. Ceram. Soc.*, **10** [1], 1–2 (1931).—By showing the great progress evidenced in the increasing amount of information and knowledge becoming available every day it is pointed out that this is a time for specialization. The need for collective efforts became apparent many decades ago. In order to keep up with experts in any line, it is necessary to have the daily increments of knowledge in the special work as they are made. This necessitates organizations of experts with facilities to make current collections and to publish periodically this information from all parts of the world. This is the reason the AMERICAN CERAMIC SOCIETY is functioning and the reason it is divided into industrial divisions. E.J.V.

Testing mine air. ANON. *Glückauf; Queensland Govt. Mining Jour.*, **31** [11], 470 (1930).—A simple and reliable apparatus for testing mine air in Germany is described. E.P.R.

Aim of engineering education. P. W. SWAIN. *Power*, **72** [18], 686–87 (1930). H.W.A.

Colorado feldspar grinding plant. JOSEPH C. CIYLE. *Rock Prod.*, **33** [25], 56–57 (1930).—C. describes the operations and equipment of the Western Feldspar Milling Co., Denver, Colo. A blend of raw material from several quarries is used. The operators were troubled with clogging of the grinding mills due to excessive static magnetism or cohesiveness of the ground feldspar but this was overcome by the invention of a special separator. Feldspar is produced for use in porcelain, pottery, enamel, tile,

and glass. The plant output is fifty 45-T. cars per month when running three shifts with three men per shift. The analyses of the 200-mesh and 20-mesh products are given. Illustrated. W.W.M.

Porcelier Manufacturing Co. ANON. *Ceram. Ind.*, **16** [1], 50–53 (1931).—The new plant and equipment of the Porcelier Mfg. Co., Greensburg, Pa., are described and illustrated. The general method of operations is given. W.W.M.

Federal Glass Co. plant. ANON. *Amer. Glass. Rev.*, **50** [11], 14 (1930).—Manufacturing requirements of the Federal Glass Co., one of the country's large manufacturers of tumblers, tableware, glass dinnerware, and packer's ware, have resulted in the addition of five new buildings to the plant in Columbus, Ohio, since September. The increased facilities will provide the company with needed space in which to meet the expansion in demand for Federal ware which is anticipated in 1931. E.P.R.

Exposition of chemical industries. ANON. *Amer. Glass Rev.*, **50** [14], 14 (1931).—During the week of May 4 to 9, inclusive, 1931, the 13th Exposition of Chemical Industries will be held at the Grand Central Palace, New York. E.P.R.

Review of glass industry for 1930. ANON. *Nat. Glass Budget*, **46** [36], 3 (1931).—A review of the activities in the glass industry during the past year shows that demand and production in every branch of the industry fell below that of the preceding year. E.P.R.

Belgian glass industry. ANON. *Nat. Glass Budget*, **46** [35], 5 (1930).—The Belgian sheet-glass market is improving slowly with alternative bookings from several foreign countries. E.P.R.

German Glass Technical Society. H. MAURACH. *Sprechsaal*, **63** [49], 931–35 (1930).—The situation of the glass industry in Europe for the year 1929–1930 is discussed in regard to (1) the rationalization of the industry, (2) production of optical glass, (3) plate glass, (4) pane glass, (5) bottle glass, (6) illuminating glass, (7) pressed glass, (8) apparatus glass, (9) white hollow glass, (10) heat technique, and (11) improvement of the quality of glass. M.V.K.

Meeting of the German Ceramic Society. ANON. *Tonind.-Ztg.*, **54** [99], 1545–46 (1930).—The German Ceramic Society met in Nuremberg in September. M.V.K.

Argentine building industry. DIETRICH NIEBUHR. *Tonind.-Ztg.*, **54** [96], 1497–99 (1930).—A description of the brick, lime, roof, tile, plate, and cement industries in Argentina is given. M.V.K.

Leipzig fair. P. VASS. *Schaulade*, **6** [15], 1025–40 (1930).—The Leipzig world fair will be held March 1–7, 1931. A fine display of china and ceramic ware from many countries is promised. M.V.K.

BOOKS AND PAMPHLETS

Power and Heat Economy in Industry. (Kraft und Wärmewirtschaft in der Industrie.) M. GERBEL AND ERNST REUNTLINGER. Julius Springer, Berlin, 1930. 338 pp. 102 illustrations. 20.00 Rm. Reviewed in *Keramos*, **9** [23], 889 (1930).—The following topics are discussed: (1) industrial power and heat needs of different industries; (2) principles of drying and boiling liquids, evaporation, and distillation from the heat-technical standpoint; (3) industry of current generation and its basis with interesting conclusions on the rentability of steam and water power; (4) cement and lime industries; (5) fine ceramic industry; and (6) steam management: the utilization of waste steam and calculations. M.V.K.

Prospecting and Drilling Clay Deposits. (Das Aufsuchen und Abbohren von Tonlagerstätten.) M. IGEL. Tonind.-Ztg., Berlin, 1930. 28 pp. Rm. 1.80. Reviewed in *Tonind-Ztg.*, **54** [100], 1562 (1930).—Important problems in prospecting and drilling clay deposits, ways of determining the use of the excavated clay from samples, and methods of testing are discussed. M.V.K.

Mechanical World Year Book. ANON. Emmott and Co., Ltd., Manchester, 1931. 44th ed. 358 pp. *Mech. World*, **88** [2293], 559 (1930).—By introducing new sections each year this publication has become a source of reliable information on important modern engineering problems. E.P.R.

Mechanical Engineers' Handbook. LIONEL S. MARKS. 3rd ed. 2264 pp., thumb-indexed; over 1300 figures and diagrams. Price, $7.00. McGraw-Hill Book Co., New York, 1930. Reviewed in *Gas Age-Rec.*, **67** [1], 22 (1931); see also *Ceram. Abs.*, **9** [12], 1113–14 (1930). E.J.V.

From Desert to Doorstep. LIBERTY GLASS CO. *Nat. Glass Budget*, **46** [33], 13 (1930).—A pictorial review of the manufacture and use of milk bottles is presented. E.P.R.

Roads and Road Construction Year Book and Directory, 1930–31. ANON. Carriers Publishing Co., Ltd., London. 480 pp. *Refrac. Jour.*, **6** [63], 83 (1930).—The contents are divided into five parts (with sub-sections) including materials and their application, highway engineering, a directory of highway officials, and a vast amount of useful information. The chapter on brick roads is instructive. E.P.R.

Boiler House Manual. B. FRISBY. Crosby Lockwood and Son, London, 1930. *Mech. World*, **88** [2292], 542 (1930).—This book forms a clearly written and elementary treatment of the many problems which arise concerning the efficient and economical running of a boiler plant. The boiler-house attendant should find the tables of formulas for draft, boiler losses, and boiler efficiencies of direct service to him in his work. The first chapter deals with the selection of fuel, wet and dry coals, sulphur, and fusibility of ash. This is followed by a description of the different firing methods. E.P.R.

Book Reviews

Tonindustrie-Kalender. 1931. 2 vols. Tonind.-Ztg., 1930. Rm. 4.00. Published in German only. The first volume treats of laws and regulations governing the ceramic industry, labor, and the rights of industrialists and employees. Fifty pages of tables give data on the power of ceramic machines, efficiency of mills, excavators, steam engines, locomobiles, gas motors, pumps, etc. Tables showing the fuel consumption of firing kilns and results of operating tunnel kilns with direct gas firing are given, and the main groups of lime and cements are described. Standard specifications, latest testing methods, and instructions for evaluation of liquid combustibles are discussed. The second volume reviews the requirements of the building industry and covers cement, brick, heavy ceramics, refractories, sand-lime brick, lime gypsum, chalk, iron concrete, etc. M.V.KONDOIDY

Dilatation of Refractory Materials. (L'étude de la dilatation des materiaux refractaires.) R. V. WIDEMANN, A. JOURDAIN, AND H. CASSAN. La Céramique, Paris, 1930, 20 pp. The authors discuss the reversible or thermic and permanent dilatation of different refractory materials which they investigated. The refractory blocks, apparatus used, and tests are described. The results obtained by different laboratories on samples of the same composition agree well with those made by the authors. M.V.KONDOIDY

Pocket Manual for Ceramists. (Taschenbuch für Keramiker.) ANON. 2 volumes. Keramische Rundschau, Berlin, 1931. Rm. 4.00. In German only. This book is a practical guide to the latest methods and manufacturing processes for the ceramic, glass, and enamel industries. Laws and regulations, patents, and standard specifications are given and explained. An index for the ceramic, glass, and enamel industries is compiled. M.V.KONDOIDY

ADVERTISING RATES

of the

JOURNAL OF THE AMERICAN CERAMIC SOCIETY

Space	*Twelve Insertions*	*Six Insertions*
FULL PAGE	$40.00	$48.00
HALF PAGE	24.00	27.00
QUARTER PAGE	13.50	15.00
EIGHTH PAGE	7.50	8.25

Space	*Three Insertions*	*One Insertion*
FULL PAGE	$54.00	$60.00
HALF PAGE	30.00	33.00
QUARTER PAGE	16.50	18.00
EIGHTH PAGE	9.00	9.75

PREFERRED SPACE

Inside Front Cover	List plus 20%
Opposite Table of Contents	List plus 20%
First Page Before Articles	List plus 20%
End of Abstracts	List plus 10%
Center of Book	List plus 10%
First Page After Articles	List plus 20%
Opposite Inside Back Cover	List plus 20%
Inside Back Cover	List plus 20%
Back Cover	List plus 25%

Copy is due on the 5th of preceding month.

Forms close on the 15th of preceding month.

For further information, write to:

American Ceramic Society

2525 North High St.

Columbus, Ohio

Ceramic Educational Directory

THE OHIO STATE UNIVERSITY
Department of Ceramic Engineering, COLUMBUS, OHIO

Curriculum—Ceramic engineering and technology. Advanced research in coöperation with State owned plants and Federal Government

SIX INSTRUCTORS — *Head of Department:* ARTHUR S. WATTS
Founded 1895 — *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAYWORKING AND CERAMICS
ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Appied Art

NINE INSTRUCTORS — *Founded 1900* — *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY
NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering Graduate Study and Research in Ceramics

FOUR INSTRUCTORS & FOUR RESEARCH ASSISTANTS — *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS
Department of Ceramic Engineering — *Founded 1905* — URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate — *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE
Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and ornamental ceramics

FOUR INSTRUCTORS, TWO COURSES — *Founded 1906* — *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA
Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS — *Founded 1910* — *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON
Department of Ceramic Engineering, SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics
Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON — *Founded 1918* — *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN
SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS — *Founded 1921* — *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE
Department of Ceramics, School of Mines and Metallurgy
STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW — *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY
ATLANTA, GEORGIA

CERAMIC DEPARTMENT — *Curriculum*—Ceramic Technology and Engineering
TWO INSTRUCTORS — *Founded 1923* — *Director:* A. V. HENRY

VIRGINIA POLYTECHNIC INSTITUTE
BLACKSBURG, VIRGINIA

Curriculum—Ceramic Engineering

Founded 1929 — *Head of Department:* J. W. WHITTEMORE

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING
RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 — *Curriculum*—Ceramic Engineering
THREE INSTRUCTORS — *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY
MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—Chemical and engineering principles applies to ceramic manufacture

TWO INSTRUCTORS AND TWO ASSISTANTS *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO
TORONTO, CANADA

Founded University, 1827; Department of Metallurgy, Ceramic Division, 1925

Curriculum—Ceramic Engineering and Technology

TWO INSTRUCTORS *Principle Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES AND METALLURGY
OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON *Founded 1926* *Head of Department:* M. E. HOLMES

UNIVERSITY OF CINCINNATI
CINCINNATI, OHIO

Dept. School of Applied Art, Ceramic Dept.

Curriculum—Coöperative training in ceramic art and technology to develop designers for ceramic industries

Founded 1926 *Head of Department:* HAROLD S. NASH

THE OHIO STATE UNIVERSITY
Department of Fine Arts, COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries

THIRTEEN INSTRUCTORS *Head of Department:* JAMES R. HOPKINS

Founded 1927 *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA
NORMAN, OKLAHOMA

Dept. of Ceramics, School of Fine Arts *Curriculum*—Ceramic Art

Founded 1927 *Head of Department:* JOHN N. FRANK

UNIVERSITY OF ALABAMA
UNIVERSITY, ALABAMA

Ceramic Option Course, Founded 1928

Curriculum—Technical ceramic courses given by Dept. of Chemistry and Metallurgy

TWO INSTRUCTORS *Director:* STEWART J. LLOYD *Ceramics:* T. N. MCVAY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE, MASS.

Curriculum—Graduate Study and Research in Ceramics

FIVE INSTRUCTORS *Founded 1929* *Head of Course:* F. H. NORTON

LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE
BATON ROUGE, LA.

Curriculum—Optional Courses now given by the Department of Geology

THREE INSTRUCTORS *Ceramics Dept. founded 1925* *Head of Dept.:* H. V. HOWE

STANFORD UNIVERSITY
Department of Mining Engineering, STANFORD UNIVERSITY, CALIFORNIA

Curriculum—Two-year graduate course in ceramic engineering, offering various combinations with mining and metallurgical engineering. Research in ceramics and non-metallics.

Director: THEODORE J. HOOVER *Founded 1925* *Professor in charge:* W. F. DIETRICH

OKLAHOMA AGRICULTURAL AND MECHANICAL COLLEGE
STILLWATER, OKLA.

Department of Ceramics, School of Engineering

Curriculum—Ceramic Option—Chem. Eng.

ONE INSTRUCTOR *Founded 1928* *Head of Dept.:* L. F. SHEERAR

An Important Family of Ceramic Materials

ZIRCONIUM and Titanium are related elements. With an inexhaustible supply of raw materials, we have been studying the properties of these two elements and their compounds for almost a quarter of a century.

The extraordinary advantages of Zirconium and Titanium products in the Ceramic Industries have long been known. In the development of Opax (Zirconium Oxide) our laboratories have been continuously engaged in researches on other Zirconium and Titanium compounds.

We are now in a position to supply all of the materials listed here, and will be glad to furnish data and suggestions covering the advantages in the use of these products.

Send for new price list.

The Titanium Alloy Manufacturing Company

Ceramic Materials Division

1204 Keith Building, Cleveland, O.

BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

E. DEF. CURTIS, MYRTLE M. FRENCH, ERWIN SOHN, W. N. HARRISON	Art, Enamel	J. T. LITTLETON, A. N. FINN, C. F. GEIGER, DOROTHY A. TEXTER, R. F. SHERWOOD, E. H. FRITZ	Glass, Refractories, White Wares	H. D. CALLAHAN, L. A. DOUGHERTY, HOWELLS FRECHETTE, W. H. VAUGHAN	Terra Cotta, Heavy Clay Products

OFFICERS OF THE SOCIETY

EDWARD ORTON, JR., President
1445 Summit St., Columbus, Ohio
PAUL E. COX, Vice-President
Iowa State College, Ames, Iowa
H. B. HENDERSON, Treasurer
Standard Pyrometric Cone Co., Columbus, Ohio
ROSS C. PURDY, General Secretary and Editor
EMILY C. VAN SCHOICK, Assistant Editor
2525 N. High St., Columbus, Ohio

TRUSTEES

GEORGE A. BOLE
M. C. BOOZE
B. T. SWEELY
C. D. SPENCER
H. C. KLEYMEYER
J. M. MCKINLEY
EDWARD SCHRAMM
E. DEF. CURTIS
D. F. ALBERY

Vol. 10 **March, 1931** **No. 3**

EDITORIAL

TO WHOM ARE YOU INDEBTED?

Are you self-sufficient?

Does your library cover the world's literature?

Is your laboratory staff independent of information from outside?

Are your plant operators creators of the methods and equipment they use without knowing what others are doing?

Is your plant up-to-date because your staff is self-sufficient?

Do you know of any development in science or industry creditable alone to one man or to one laboratory staff?

Do you believe that the so-called "self-made man" creates independently in his own mind the things he knows?

You, like a lot of others, may not go to church; you may believe you can make better use of your Sundays. Would you live in a no church community?

You may not be supporting your Chamber of Commerce, and you may not be in sympathy with the National Chamber, but can you convince yourself that such organizations are not essential to your community and to business?

You may agree with a lot of other folks that our schools and methods are all "hay wire" but would you agree to close up the schoolhouses and not pay your school tax?

You may, as do many people, have conscientious objections to secret societies and orders. You may be out of sympathy with the Christian associations, the Red Cross, community charity organizations, and other similar collective efforts to accomplish definite things. But would you say that they are without value to your community and thus to you personally?

There are those engaged in ceramics who do not believe that this SOCIETY has been of value to them personally and to their concerns and to ceramics in general. Would these same persons venture the belief that 2800 persons are misguided and are fooling themselves into the notion that this collaboration on the art, science, and technology of ceramics and the abstracting of the world's literature are essential to ceramic progress?

Who will gainsay that collective thinking and doing is as essential as solo thinking and doing?

Who would question the fact that all the information and devices which he uses (including their application) could not by him alone have been created?

Indebted to others? Value in collaboration? Need of the AMERICAN CERAMIC SOCIETY?

My, how much more beneficial to each and all ceramic interests this SOCIETY would be if all ceramic persons and firms would think this through to a realization of their indebtedness to others, and to a realization of the necessity of organized collaboration.

ACTIVITIES OF THE SOCIETY

BIOGRAPHICAL SKETCH OF DR. M. LUCKIESH

Director, Lighting Research Laboratory, General Electric Co.

The message "from without" at the Monday forenoon general session of the Meeting of this SOCIETY in Cleveland was delivered by Dr. M. Luckiesh.

Having decided to obtain a scientific education, at the age of twenty-one Mr. Luckiesh entered Purdue University from which he was graduated in 1909 with the degree of Bachelor of Science in Electrical Engineering. In 1912 he received the degree of Electrical Engineering from Iowa State College and in 1911 the degree of Master of Science. In 1926 Iowa State College conferred upon him the degree of Doctor of Science.

In 1910 Mr. Luckiesh went to Nela Park in Cleveland where he held the position of physicist in the Research Laboratories until 1920 when he became Director of Applied Science of Nela Research Laboratory. Since 1924 he has been Director of Lighting Research Laboratory.

Mr. Luckiesh developed the first accurate glass filter for the production of artificial daylight including north skylight and noon sunlight. Among his other developments are the Mazda daylight lamp, the Mazda photographic lamp, the Mazda flametint lamp, and colored accessory processes for coloring lamps. He has also designed many fixtures and some outstanding pioneering lighting installations, broadened the engineering viewpoint of lighting to include both the scientific and artistic aspects, and was a pioneer in the conception of light as a new medium of expression and in broadening the field of the illuminating engineer into that of the seeing specialist.

MATTHEW LUCKIESH

As a pioneer lighting expert Mr. Luckiesh has international reputation, his works being well known throughout the world. It was he who first advocated the use of color for creating moods and combined the scientific and artistic aspects of light in lighting fixtures to produce lighting effects. A recent masterpiece along this line is the elaborate installation he made in the National Broadcasting Studios in New York City. He has carried this idea, on a smaller scale, into the home where he has done considerable work on the development of lighting fixtures which produce a variety of lighting effects suitable for specific rooms and specific purposes.

He has been the leader in the analysis and development of the possibilities of residential lighting, having conducted several surveys along this line. Much of the progress in residential lighting has been due to the interest aroused by his surveys of the prevailing conditions and future possibilities in that field supplemented by the development of fixtures and lighting recipes.

Another field in which Mr. Luckiesh has been very active is that of lighting for the work world. For many years he has worked to replace the localized lighting of the early days with good general lighting in work places. In advocating and installing general lighting, localized lighting was abandoned almost entirely. A few years ago Mr. Luckiesh initiated the idea of advocating high intensities of general lighting to supplement the even much higher intensities of localized lighting.

Twenty years of research in lighting and vision, as they pertain to seeing, have brought him to a realization of the fact that seeing is really a partnership of lighting and vision. For years Mr. Luckiesh has been directing research toward the develop-

ment of a new science of seeing, and laying the foundation of this new science which is the result of the partnership of lighting and vision.

Another new era which has just appeared on the horizon is the use of artificial sunlight, as distinguished from daylight, which includes health-giving rays as well as light for vision. Here again Dr. Luckiesh pioneered in the development of a new era of lighting for health combined with lighting for seeing.

The results of his extensive researches in the scientific and psycho-physiological aspects and relationships of light, color, lighting, and vision, both from the standpoint of the production and of the utilization of light, are published in the sixteen books and hundreds of scientific and technical articles which he has written. Many of these have been published abroad and make him the best known man associated with light, color, lighting, and vision.

Dr. Luckiesh is a member of many societies, including the National Electric Lighting Association, the Illuminating Engineering Society, the American Institute of Electrical Engineers, the American Physical Society, the Franklin Institute, the Optical Society of America, etc. He has been especially active in the Illuminating Engineering Society, having served in various capacities such as President, Director, Chairman of various committees, etc., and was awarded the Edward Longstreth Medal and certificate of merit by the Franklin Institute for his work on the visibility of airplanes during the World War. It was at this time that he served as Chairman of the Committee on Camouflage of the National Research Council. Mr. Luckiesh is also a member of the Sigma Alpha Epsilon, the Tau Beta Pi, and the Sigma Xi fraternities.

AUDIT REPORT, YEAR 1930

Columbus, Ohio,
January 17, 1931

AMERICAN CERAMIC SOCIETY,
Columbus, Ohio.

Gentlemen:

Herein is my report on the audit of the accounts of the AMERICAN CERAMIC SOCIETY for the year ending December 31, 1930, the results being shown in attached statements as follows:

I. Statement of Assets and Liabilities, as of December 31, 1930.

II. Income and Expense Statement for the year ending December 31, 1930.

All cash received has been properly recorded and deposited, and all payments were made by duly authorized and properly signed voucher check.

After careful audit, it is my opinion that this report correctly shows the financial operations of the AMERICAN CERAMIC SOCIETY for the year 1930, and the true condition at the close of the year.

Respectfully submitted,
A. L. PETERS
Certified Public Accountant.

STATEMENT I
Statement of Assets and Liabilities
(As of December 31, 1930)

Assets			
Cash in Bank (General Account)		$2,075.89	
Cash in Revolving Fund		400.00	
Petty Cash		5.00	$ 2,480.89
Liberty Bonds (par $9700)		9,861.00	
Certificate of Deposit		858.84	10,719.84
Accounts Receivable			2,468.93
Inventories			
Journals		1,145.59	
Transactions		565.00	
Refractory Bibliographies		268.20	
Enamel Bibliographies		277.00	2,255.79
Office Equipment			2,215.17
Deferred Charge			
Advance Expenses on 1931 Meeting			889.10
TOTAL ASSETS			21,029.72
Liabilities and Surplus			
Accounts Payable			7,747.22
Deferred Income			
Prepaid Dues			
Divisions	$ 559.60		
Corporations	1,960.40		
Personal	4,481.57	7,001.57	
Prepaid Journals		1,493.56	
Prepaid Curtis Survey		37.00	
Total Deferred Income			8,532.13
Surplus Account			
Balance December 31, 1929		9,734.68	
Less Excess Expenses over Income, 1930		4,984.31	
Surplus Balance December 31, 1930			4,750.37
TOTAL LIABILITIES AND SURPLUS			21,029.72

STATEMENT II
Income and Expense Statement
(For the Year Ending December 31, 1930)

			Losses	Gains
Net Gain on Divisions				$1,134.70
Collective Indexes (Sales)		$ 5.70		
Decrease in Inventory		97.90	$ 92.20	
Journal, 1930 (Sales)		4,030.39		
Advertising	$15,239.74			
Less Commissions, etc.	162.58	15,077.16		
		19,107.55		

			Losses	Gains
Printing (less Inventory)	22,676.95			
Abstracts	2,569.69	25,246.64	6,139.09	
Journal, 1919–1929 (Sales)		791.95		
Purchases	116.52			
Decrease in Inventory	361.50	478.02		313.93
Reprints (Sales)		868.49		
Cost		1,525.92	657.43	
Seger's Writings (Sales)		119.91		
Cost		95.44		24.47
Transactions (Sales)		182.50		
Cost	25.00			
Decrease in Inventory	10.00	35.00		147.50
Refractory Bibliographies (Sales)		35.65		
Decrease in Inventory		10.80		24.85
Enamel Bibliographies (Sales)		50.63		
Decrease in Inventory		78.00	27.37	
			6,916.09	1,645.45
Loss on above activities				5,270.64
			6,916.09	6,916.09
Above *loss* brought down				5,270.64
General Income				
Earned Dues: Corporation		5,951.35		
Personal		16,153.19		
A. R. I.		954.50	23,059.04	
Interest Income			535.28	
Miscellaneous Income			1.00	
Total General Income			23,595.32	
General Expenses				
Salaries		14,759.75		
Office Expenses— Secretary	2,366.21			
Editor	1,837.30			
Other	14.00	4,217.51		
Office Rent		1,080.00		
Postage		1,379.26		
Traveling Expenses		480.64		
Meeting Expense (net)		798.44		
Committee Expense		15.80		
Bad Accounts charged off		187.21		
Depreciation on Office Equipment		246.13		
Miscellaneous Expenses		144.25		
Total General Expenses			23,308.99	
Gain on General Items				286.33
Net *Expenses* over Income				4,984.31

A CHARTER MEMBER WRITES

Letter of Greeting from W. D. Gates

"Trails End,"
Crystal Lake, Ill.
January 13, 1931.

MY DEAR PURDY:

Much as I should like to attend the coming Meeting, I feel that it cannot be. Too many things interfere. One is that I should be, mainly, among strangers, new faces, new names, younger, progressive, energetic, vigorous, and with a future to be filled with accomplishment. There would be the very cherished few of the survivors from the start only to be lost in the crowd of the new.

Really, I died two years ago, only in some way, they neglected to bury me. I am on the downward side of 79 and just walking, beating time, just keeping close at home, and dreading going anywhere. Then too, I must consider others. We have, in our little town, two rival undertakers both of whom have had me much in mind for the last two years. They look at me wonderingly, inquiringly, and, I think, wistfully. If I should leave town they would be very nervous as to my falling into the hands of outside morticians. And really I feel that I should give them my business. Christmas afternoon, one of them came to the house bearing a big bundle, and when I hastened out to shoo him away, he explained that he was appearing in his capacity as florist, and not undertaker, and was delivering a handsome poinsettia to me, ordered by phone by a distant friend. It gave me quite a start, almost thought they were sending the flowers and going on with the funeral anyway.

Makes me almost feel as though I should, myself, arrange for all the last rites, simplifying them, getting them quickly over so as not to agonize the few that do know and love, and not embarrass the larger crowd who would come from a sense of sympathy.

In view of my having died two years ago, I might arrange to suggest a text for a sermon, say, John, 39: "Martha, the sister of him that was dead, saith unto him, Lord, by this time he stinketh." So, if I being dead two years while in his case it was only four days, wouldn't it be an appropriate text?

Well, I am not yet buried; am bent, but not broke; someway I do feel that as long as I was not buried, when due, when ripe, when dead—it may be that there is something for me to do yet, even on borrowed time.

At my age, there isn't much to look forward to in the mists of the future and there comes retrospection, the looking back to the old times and the old friends. And what royal and loyal friends they were, some grown old and grizzled, still this side the mist, some, cherished and dear, waiting on the other side. What a wonderful bunch they were, gathered there to launch the SOCIETY, starting something bigger than they, that would grow world wide, would outlast them, grow beyond their fondest dreams, and accomplish results by them undreamed of. Surely, we built bigger than we knew. I well recall, when we got out that thin little Volume 1, how we looked at one another, amazed, saying "We didn't think we could do it, but we have exhausted the subject, can never do it again." Each tried to do his part, according to what was in him. I recall that I proudly carried the manuscript of the translation of Seger, I not being able to read the original. This was fitting and proper, the Almighty having developed me more liberally below the ears than above, so I gave my offering physically, while the others gave mentally.

If I could, with a clear conscience, avoid the morticians and come and exhibit my white hair and quit there, I would be tempted to come. But I know my weakness.

Just can't keep my mouth shut and thus would give myself away, the mouth being developed with that part below the ears.

Give my love to the old bunch whose memory I cherish above all, and with very best wishes to you all and for you all,

Sincerely,
WM. D. GATES

SECRETARY'S LETTERS

Washington, D.C.
February 5, 1931

MY DEAR MR. PURDY:

I have just been reading the activities of the SOCIETY, especially your own letter, and wish to compliment you most highly on the splendid work which the AMERICAN CERAMIC SOCIETY is doing and on the continually improving nature of its publications which would be a credit to any organization.

With best of good wishes to yourself,

Sincerely yours,
CHARLES L. PARSONS, *Secretary*,
American Chemical Society

LOCAL SECTION NEWS

Baltimore-Washington Section

The officers of the Baltimore-Washington Section of the AMERICAN CERAMIC SOCIETY for the year 1931 are as follows:

Chairman: W. N. Harrison
Vice-Chairman: E. G. Greenstreet
Secretary-Treasurer: E. B. Filbert
Councilor: R. A. Heindl

Program Committee
L. J. Trostel
W. A. Weldon
R. F. Geller

The November meeting of the Baltimore-Washington Section was held November 15, 1930, at the Tilden Gardens Club Building, Washington, D. C.

Following the usual dinner Chairman Harrison called the meeting to order, and read a letter from R. C. Purdy concerning plans for the Annual Meeting of the AMERICAN CERAMIC SOCIETY to be held in 1932 in Washington, D. C. A motion to instruct the Secretary of the Local Section to extend an invitation to the National organization to hold the 1932 Annual Meeting in Washington was carried.

P. K. Devers, General Electric Co., Lynn, Mass., read a paper on "Fused Quartz." He described the source of raw materials, the early attempts to produce this unique material, and the methods developed by the General Electric Co. for commercial production.

One of the two methods used is the electric furnace method of fusion with evacuation to remove gases, followed by a pressure treatment to reduce seeds. The second method is a flame-spraying process in which the crystalline quartz is fed to the flame with the gases, fused in the flame, and deposited on the article under construction.

The advantages of fused quartz are its low thermal expansion, high corrosion, and electrical resistance.

It is used for high-temperature therometers, lenses, chemical apparatus, and reflectors for astronomical telescopes.

Following Mr. Devers' talk there were interesting discussions by the Section members and Mr. Devers.

The January meeting was held January 24, 1931, at the Emerson Hotel, Baltimore, Md. Twenty-nine members were present. The minutes of the previous meeting were read and an amendment to them was added to the effect that, as E. A. Porst had left Baltimore and would not be able to serve as Secretary-Treasurer for the year 1931, Edwin B. Filbert be elected to fill this position.

D. H. Rowland, head of the research department of the Locke Insulator Corporation, Baltimore, Md., gave a talk on "High Tension Porcelain." The development of insulators and their construction was discussed and he pointed out that at the present time more porcelain than glass is used for this type. Mr. Rowland then took up the composition of the body, glaze, and the cementing of the hardware to the fired porcelain.

He discussed the strength of the insulator and showed how this has increased from 9000 pounds per square inch in 1915 to 26,000 pounds per square inch in 1931. This is due to the development of the high-voltage transmission lines. On lines of this type carrying 220 kv there are from 16 to 18 skirts bolted together to carry one line from a tower and as the voltage increased or decreased the number of skirts was governed accordingly.

After the talk the time was spent by the members in asking questions. This developed into an interesting discussion.

Pacific Northwest Section[1]

At the annual winter meeting of the Pacific Northwest Section of the AMERICAN CERAMIC SOCIETY the following officers were elected:

A. B. Fosseen, *President*, Washington Brick, Lime, and Sewer Pipe Co., Spokane, Wash.
G. L. Rogers, *Vice-President*, Gladding, McBean and Co., Seattle, Wash.
H. O. Thompson, *Treasurer*, Builders' Brick Co., Seattle, Wash.
Hewitt Wilson, *Secretary*, University of Washington, Seattle, Wash.
Samuel Geijsbeek, *Councilor*, Geijsbeek Engineering Co., Seattle, Wash.

A partial attendance list follows.

Name	Business	Town
I. Geo. Adderson	Gladding, McBean & Co.	Taylor
L. A. Martin	" " "	Wenatchee
W. E. Lemley	" " "	Taylor
E. E. Saunders	" " "	Spokane
F. A. Callarman	Public Accountant	Seattle
M. K. Stockdale	Sec.-Treas. Skagit Talc, Inc.	"
A. E. Moline	Salesman of Skagit Talc Prod.	"
O. K. Edwards	Willamina Clay Products Co.	Portland
G. H. Waterman	Mfrs. Mineral Co.	Seattle
A. B. Fosseen	Wash. Brick Lime & Sewer Pipe Co.	Spokane
H. E. Clem	Student	Seattle
Fred Kettenring, Jr.	"	Vancouver, Wash.

[1] For program see *Bull. Amer. Ceram. Soc.*, **10** [2], 46 (1931).

H. G. Wilcox	Research Fellow	Seattle
George A. Page	" "	Rolla, Mo.
Charles Butler	Student	Seattle
Jess E. Tharp	"	"
F. A. Hawks	H. O. Scoffert Co.	Everett
Roy Sievers	" " " "	"
W. P. Palin	National Refractory Co.	Tacoma
H. P. Palin	" " "	"
H. M. Holway	Vitrefrax Corp.	Seattle
Madeline Flint Hosmer	Potter	"
James Hodgkiss	Port Haney Brick Co.	Vancouver, B. C.
F. W. McKenzie	Skagit Talc Co.	Seattle
C. F. Moline	" " "	"
J. D. Williams	Student	Kellogg, Idaho
E. J. Hutmacher		Seattle
Carl V. Gezelius	Student	"
Chas. Doumani	"	"
T. E. Nicholson	Gladding, McBean & Co.	Auburn
E. Davies		
C. A. Ohlin	Gladding, McBean & Co.	Renton
F. T. Houlahan	Builders Brick Co.	Seattle
W. J. Howard	Brick & Tile Assn.	"
S. R. Mercer	Gladding, McBean & Co.	Renton
Gregory L. Rogers	" " "	Seattle
Nels E. Johanson	George Scofield Co.	Tacoma
H. Hoffmann	Lake Union Brick Co.	Seattle
J. P. Hammock	Student	"
J. C. Hoskin	Gladding, McBean & Co.	Renton
Geo. H. Krueger	F. T. Crowe Corp.	Seattle
L. R. Kemoe	" " " "	"
Willis E. Clark	Gladding, McBean & Co.	"
Raymond R. Smith	" " "	"
Joseph Daniels	University of Washington	"
Milnor Roberts	" " "	"
Kenneth G. Skinner	Student	"
J. H. Yates	Ceramic Lab. Univ. of Wash.	"
George Middleton	Student	"
Hewitt Wilson	University of Washington	"
Wurth W. Kriegel	Aberdeen Clay & Color Co.	Aberdeen
John Stirrat	Seattle Brick & Tile Co.	Seattle

St. Louis Section[1]

A meeting of the St. Louis Section of the AMERICAN CERAMIC SOCIETY was held January 29 at the Melbourne Hotel, St. Louis, Mo.

A five-reel motion picture film loaned through the courtesy of the Harbison-Walker Refractories Co. was presented by C. G. Eickmeyer. The film illustrates the various processes of manufacturing fire brick from the mining of the raw materials to the finished product.

California Section[2]

A meeting of the California Section of the AMERICAN CERAMIC SOCIETY was held at the Engineer's Club, Los Angeles, Monday, January 12. The officers elected for the year 1931 are as follows:

Ivan B. Branham, *Chairman*, Batchelder Wilson Co.
Gus Larson, *Vice-Chairman*, Los Angeles Brick Co.
Vernon R. Sullivan, *Vice-Chairman*, Stockton Fire Brick Co.

[1] Wallace Thoreson, *Secretary*.

[2] John S. Lathrop, *Secretary*.

John S. Lathrop, *Secretary*, Calco Tile Mfg. Co.
A. T. Wintersgill, *Treasurer*, Pacific Clay Products Co.
P. D. Burtt, *Member Executive Committee*, Illinois-Pacific Glass Co.
Max Compton, *Member Executive Committee*, Gladding, McBean & Co.

After the election of officers the following program was offered:

C. J. Simmons of Gladding, McBean & Co., gave a creditable paper on "Plant Control," explaining how the human element and the factor of chance are controlled in their factories by means of accurate control.

Robert T. Miller, of Lange & Miller, Management Councilors, delivered an enlightening paper on "Budget Control of Business," a paper which was well received and which created considerable discussion.

E. W. Morris of the Engineering Department of Westinghouse Electric and Manufacturing Co. gave an interesting illustrated talk on "The Care of Electric Motors," stressing the essential difference between sleeve bearings and roller bearings and the economic value of knowing where to use each kind for best service.

Cecil Jones of Claycraft Potteries proposed that a history of ceramics in California be compiled. This was taken under advisement by the chairman who will appoint a committee to perfect this history.

NEW MEMBERS RECEIVED IN JANUARY

Corporation

American Lava Corporation, Paul J. Kruesi (voter), Chattanooga, Tenn.
Colonial Insulator Co., R. W. Hemphill (voter), 973 Grant St., Akron, Ohio.

Personal

Jay O. Achenbach, Philadelphia Electric Co., Philadelphia, Pa.
Bernard Thorpe Barkwell, Works Manager, Pickford, Holland & Co., Ltd., Moor Edge Silica Brick Works, Totley, Sheffield, England.
Henry Charles Biggs, Technologist, J. G. Stein & Co., Ltd., Bonnybridge, Scotland.
Freida Louise Hammers, Research Assistant in Ceramics, University of North Dakota, University Station, Grand Forks, N. D.
John J. Hazel, Chemical Engineer, Harbison-Walker Refractories Co., Vandalia, Mo.
Fred Hetu, Apt. 2, 368 Laurier Ave. West, Montreal, Quebec, Canada; General Manager, Quarry Products, Ltd.
Frank L. Marsh, Medicine Lodge, Kansas; Director of Research and Chief Chemist, Best Bros. Keene's Cement Co.
Howard D. Meincke, President, A. M. Meincke & Son, Inc., 7 S. Dearborn St., Chicago, Ill.
Robert Anderson Miller, Technical Sales Engineer, Pittsburgh Plate Glass Co., 2200 Grant Bldg., Pittsburgh, Pa.
John Blackburn Murgatroyd, 5 Waldeck Rd., London W. 13, England; Glass Technologist, British Hartford-Fairmont Syndicate, Ltd.
Thomas Parker, 723 Elm St., Martins Ferry, Ohio; Ceramic Instructor, Wheeling High School, Wheeling, W. Va.
Fred W. Peterson, 1277 Bryden Rd., Columbus, Ohio; Assistant Ceramic Engineer, Claycraft Mining & Brick Co.
Harry J. Sigwart, 732 Beechurst Ave., Morgantown, W. Va.; Chemist, Seneca Glass Co.
R. J. Spence, Babcock & Wilcox Co., Candler Bldg., Atlanta, Ga.
John Anthony Sugden, 1 Claremont Terrace, Norton-on-Tees, Co. Durham, England; Ceramic Chemist, Imperial Chemical Industries, Ltd.
Homer Gordon Thomson, 1441 44th St., Milwaukee, Wis; A. O. Smith Corp.
Edward D. Turnbull, 500 Penn Ave., Scranton, Pa.; Chemical Engineer, Euston Lead Co.
Lance Turnbull, 5941 Rita Ave., Huntington Park, Calif.; Ceramic Engineer, Vitrefrax Corp., Los Angeles, Calif.

STUDENT

Adrian G. Allison, Ohio State University, Columbus, Ohio.
Robert S. Green, University of Missouri, Rolla, Mo.
Roy Edison Jordan, Jr., Rutgers University, New Brunswick, N. J.
Alfred A. Mitchell, University of Missouri, Rolla, Mo.
Andrew Leo Parana, Pennsylvania State College, State College, Pa.

Membership Workers' Record

CORPORATION	
Office	2

PERSONAL	
J. E. Brinckerhoff	1
W. E. Budge	1
Paul E. Cox	1
C. E. Fulton	1
J. Holland	1
W. A. Hull	1
G. M. Hutt	1
J. F. Hyslop	1
J. S. McDowell	1
R. T. Stull	1
C. F. Tefft	1
W. E. S. Turner	2
Office	5
Total	18

STUDENT	
J. L. Carruthers	1
C. M. Dodd	1
R. G. Mills	1
J. B. Shaw	1
Office	1
Total	5
Grand Total	25

ROSTER CHANGES IN JANUARY

CORPORATION*

Associated Tile Manufacturers, H. L. Gaardsmoe (voter), 420 Lexington Ave., New York, N. Y. (M. A. Illing (voter).)

PERSONAL*

Burr, Robert B., Columbus National Bank, Columbus, Ga. (183 Poplar Circle, Atlanta, Ga.)
Clemens, Eugene C., Cannelton Sewer Pipe Co., Cannelton, Ind. (204 Ceramic Bldg., Urbana, Ill.)
Douglas, Freeman S., Babcock & Wilcox Co., Box 923, Augusta, Ga. (Box 108, E. Liverpool, Ohio.)
Eatherton, Clarence Z., Buckeye Clay Pot Co., Toledo, Ohio. (Porcelain Products Inc., Parkersburg, W. Va.)
Fitzgerald, A. E., 118 Narberth Ave., Narberth, Pa. (106 S. 16th St., Philadelphia, Pa.)
Forman, L. P., 406 California Ave., Oakmont, Pa. (American Window Glass Co., Arnold, Pa.)
French, Gordon E., 173 Cameron St., Rochester, N. Y. (Box 381, Woodbridge, N. J.)
Gano, J. R., Hegeler Zinc Co., Danville, Ill. (Membership transferred from Robert A. Whitfield.)
Gotham, Thomas B., Darm's Hotel, San Fernando Blvd., Burbank, Calif.; Empire China Co. (San Mateo, Calif.)
Hemstegger, Samuel E., U. S. Gypsum Co., 300 W. Adams St., Chicago, Ill. (48 St. Marks Place, New Brighton, S. I., N. Y.)
Lampe, Chester E., 609 East Healy, Champaign, Ill. (728 South 8th St., Quincy, Ill.)
Lang, George F., Vice-President, Carr-Lowrey Glass Co., Baltimore, Md. (Membership changed from August F. Kammer, 606 Liggett Bldg., New York, N. Y.)

* Addresses within parentheses ( ) represent the old address.

These roster changes which are published each month may be checked against the complete Membership Roster which appeared in the July, 1929, issue of the *Bulletin*. Copies of this issue may be secured from the Secretary's office, price $2.00.

Lynn, Don C., Koppers Research Corp., Mellon Institute, Pittsburgh (13), Pa. (Smithton, Pa.)
Martz, Joseph A., 38 East 18th Ave., Columbus, Ohio. (P. O. Box 274, Newton Falls, Ohio.)
Miller, Robert V., 356 Concord, Greensburg, Pa. (821 Orchard Lane Ave., East Liverpool, Ohio.)
Murphy, Remington M., 509 W. Third St., Elmira, N. Y. (35 E. Pultney St., Corning, N. Y.)
Owens, J. B., 32 Snediker Ave., Brooklyn, N. Y. (509 W. 33rd St., New York, N. Y.)
Searle, A. B., Charlbury, Oxon, England. (440 Glossop Road, Sheffield, England.)
Svec, J. J., 5 N. Huron St., Wheeling, W. Va. (1304 Clinton Ave., Berwyn, Ill.)
Thomas, Robert R., Jr., 333 Page St. E., Flint, Mich. (3025 Forest Place, East St. Louis, Ill.)
Walsh, Edward R., Dickinson Fire & Pressed Brick Co., Dickinson, N. D. (594 Jefferson Ave., Elizabeth, N. J.)
Winburn, H. L., 1602 Swan Drive, Tulsa, Okla. (301 Center St., Little Rock, Ark.)

NOTES AND NEWS

CERAMIC SCHOOL NOTES

New York State School of Clay-Working and Ceramics

Plans for the new Ceramic Building are progressing. President Davis of the University, Dr. Binns of the Ceramic School, and Dr. Wilson of the State Education Department met in Corning with Dr. Sullivan of the Corning Glass Works to discuss suggestions for the glass laboratory which is to be a part of the new equipment. Through the efforts of Dr. Schmidt and Dr. Horner of the State Education Department the plans are being drawn up in the State Architect's office and it is hoped that bids will be let very soon so that excavation may begin early in the spring.

Early in December, a party of Senior engineers with Professor Amberg visited ceramic plants in the vicinity of Corning, New York. These included the Corning Terra Cotta Co., Corning and Steuben Glass Works, and the Hawkes Glass Company. At the Hawkes plant, the processes of engraving and etching were explained by Mr. Hawkes.

A group of films on manufactured abrasives was shown at the last meeting of the Student Branch of the AMERICAN CERAMIC SOCIETY. These were taken at the Carborundum plant and loaned through the courtesy of the Bureau of Mines.

Beta Pi Kappa, the honorary ceramic fraternity, is planning to carry through a survey of the manufacture of brick in the Hudson River Valley during the spring vacation. The plants will then be opened and it is expected that a pamphlet will be compiled from the data collected. Nothing of this sort has been done heretofore and the information will be of considerable value.

Meredith Barton, '32, gave an illustrated lecture on ceramics before a high school audience in Emporium, Pa., early in January. This is one of the first manifestations of a group of projects sponsored by Beta Pi Kappa.

Milton D. Burdick, '30, has recently accepted a position with the Cement Testing Laboratory of the Bureau of Standards in Washington, D. C.

Robert M. Campbell, '23, is now connected with the Trenton Potteries, Inc., of Trenton, N. J.

EVERYDAY CERAMICS[1]

By Howells Fréchette[2]

Many of you may be wondering what are everyday ceramics. The word "ceramics" is certainly not an everyday one, though it covers hundreds of articles in common daily use. Let me explain, therefore, that the term ceramics embraces the history, art, and science of manufacturing articles from clay—brick, tile, sewer pipe, pottery, earthernware, and refractories. That is, of course, the narrowest definition. Recently the term ceramics has been extended to include the manufacture of glass and other nonmetallic mineral products as well as the metal enameling industries.

The ceramic industries have been serving mankind for countless generations. The making of pottery from clay is almost the oldest manufacturing industry in the world, basketry being the only one, probably, that antedates it. Among primitive people pottery making appears invariably to have been practiced wherever clay was available.

It is a far cry, however, from the first crude, sun-dried bowls, molded by the hands of some naked savage, to the almost endless variety of ceramic products in common use today. So common are these, indeed, that few of us at this moment can look about without seeing many examples, and it is this commonness, this familiarity, that accounts for the little thought that most people give them.

Ceramics are all about us. Many of our homes are built of brick. The walls of large buildings are faced with brick against a backing of hollow tile and the partitions and flooring fireproofed with tile. Farms are drained with tile.

China tableware of beautiful texture and decoration, earthenware, and stoneware kitchen utensils are everyday objects of usefulness. The sanitation of the home is ensured by porcelain fixtures and impervious sewer pipes: bathroom floors and walls may be of ceramic tile. Electric fixtures and wires are insulated with porcelain or glass. We fill glass tumblers from glass pitchers or glass bottles. At night we receive light from glass lamps diffused by glass shades. We improve our vision with eyeglasses. Window glass is all about us protecting us from the elements.

In the kitchen there is an array of enameled pots and pans and an enameled cook stove. The sink is enameled and the interior of the refrigerator likewise. The smoother surfaces have facilitated cleanliness, and the clear whiteness and pleasing colors have brightened this much-used room.

Ladies carry enameled vanity cases. Other examples of art enamelware as well as pieces of art pottery are to be found in every drawing room. Even the dials of our clocks and watches are usually enameled.

The ceramic industry is almost the oldest in the world. The primitive races took such clay as they found on the surface of the ground and fashioned it by hand into such shapes as need or fancy dictated. For ages tools and methods remained of the simplest form, until some original genius turned a flattened boulder into a potter's wheel. The product was hardened by simple drying in the sun until the increasing use of fire brought out the fact that clay vessels could be baked so as to be impervious to water and as hard as stone. On this discovery the usefulness and endurance of all ceramic products depend today.

Within the span of historic times progress has worked wonderful changes in the field of pottery. Various countries and ages have made their contributions, while the products have lent themselves to many forms of artistic expression: beauty of

[1] For broadcast under the auspices of the Professional Institute on Feb. 5, 1931, CNRO, Ottawa, Canada.

[2] Chief of the Division of Ceramics and Road Materials, Mines Branch, Department of Mines, Ottawa, Canada.

shape and proportion; in decoration by modeling, incision, and painting; and by the use of glazes to produce beautiful surface effects.

The tombs of the Pharaohs have revealed many examples of finely-shaped urns, vases, and cups as well as dolls, beads, and tile. Some of these, dating back 3000 years, were enameled with a beautiful turquoise blue. Persia, Greece, Rome, all produced pottery and developed shapes and modes of decoration which may be recognized in our modern ware.

In China the manufacture of pottery dates back beyond our records. It was in China that a particularly fine and useful body, "porcelain," was first compounded. Porcelain was made in China as early as 618 A.D. One authority places the date seven or eight hundred years earlier. The first of this Chinese ware to be brought to Europe is said to have come to Italy in 1487, a white, translucent porcelain that was one of the wonders of the times. Thirty years later the Portugese traders began to import it regularly.

Following the importation of porcelain into Europe, endeavors were made to produce it there, and after a great deal of experimentation, various bodies were compounded which more or less resembled true porcelain. Some of these porcelain imitations possessed such good qualities, or could be made so cheaply, that they have continued to be manufactured to the present time. The secret of true porcelain, however, was not finally discovered in Europe until 1709 when its manufacture first began.

The story of pottery and porcelain and its kindred ware is one of progress fostered by the rich and by monarchs. This progress was natural, for the beauty of this ware not only won for the industry the support of the upper classes, but drew into its ranks many artists and experimenters.

The story of brick, however, is very different. It did not share in the great strides of progress, for though its history goes back to the earliest civilizations of man, it was not until the last century that any but minor improvements were made in the methods of manufacture. The Old Testament tells us the Tower of Babel was constructed of brick, as were the walls of Babylon; brick tablets 6000 years old have been found in Ur, the city of Abraham, made by processes that endured until the introduction of machinery in the 19th Century.

From then on, however, after stagnation for thousands of years, the brick industry swung into a period of rapid progress which has culminated in almost amazing developments. It has ceased to be a rule-of-thumb trade turning out only a fair grade of ware, and now is conducted in well-designed factories operated under careful control, and producing ware to meet exacting specifications and the ever-changing demands of the public for innovations as to color and texture of the finished brick. In addition to this, engineering science has been applied to the making of other heavy clay products, hollow tile, sewer pipe, etc., building up a whole series of kindred industries where only one existed.

To the industrial world of today there is one group of ceramic products which is of paramount importance. It is the refractories, typified by fire brick. They must not only withstand very high temperatures, but also resist the action of slags and other corrosive materials with which they come in contact.

Special uses require special refractories and much research work is constantly under way to produce new or improved refractories which will meet the ever-increasing demands of industry for higher operating temperatures.

The metal-enameling industry in its history is linked with the pottery industry in that the enamel used corresponds closely to the glazes on pottery. Originally it was purely a decorative art and had a separate development in different parts of the world. It was practised by the Greeks and Romans four or five hundred years before Christ,

and probably at earlier periods in Persia, India, and China. The enamel itself was made by fusing together mineral substances producing what is known as frit. Various colored frits were obtained by the use of different metallic oxides which developed characteristic colors. The frit was finely ground and applied to objects made of copper, gold, or silver and then heated so as to fuse the frit into a lustrous, glossy coating on the metal. Cloisonné is probably the best known type of art enamel. In this the several colors employed are separated one from the other by very delicate gold bands to prevent them from running together. Champlevé is another type in which the metal to be enameled was carved leaving recesses in which the different colors were applied.

During the last century many attempts, which finally led to success, were made to enamel on iron. The solving of the technical difficulties involved has resulted in a very extensive industry which has seen immense growth in the past few years.

An interesting, though probably imaginative, story is related by Pliny concerning how the secret of glassmaking was discovered by the early Phoenicians. "Certain mariners who had a cargo of soda, having landed on a sandy shore, started a fire to cook their food, and, not finding any stones on which to rest their pots, they placed under them, in the fire, some lumps of soda from their cargo. Later they found that the heat of the fire had caused the soda to fuse with the sand, producing a transparent glass."

No matter how it was first made, we do know that glass, like other products of the ceramic industries, is of great antiquity. The art of glassmaking was known to the Egyptians 3500 years ago, and from them spread into Europe by way of Greece and Rome.

Again, as in pottery, the influence of art appreciation seems to have been a strong factor in progress. To a certain extent the introduction of machinery into the industry has suppressed art, but it has cheapened and made available to the masses the many useful forms of glass. Science is contributing generously in developing new glasses possessing properties which adapt them to new lines of service to our well-being.

Here in Canada we have all branches of the ceramic industries, producing ware that compares well with similar products of other countries. It is true that, owing to economic reasons, some lines such as high-grade table porcelain are not made in Canada, but we can and do take care of a large measure of our needs.

In the clayworking industries alone we have over two hundred operating plants representing an invested capital of almost $38,000,000, employing more than 6000 employees and producing ware to a value of over $17,500,000.

A staff of ceramic engineers, constituting the Ceramics Division of the Mines Branch of the Federal Department of Mines are engaged on researches and investigations aiming to advance the ceramic industries of Canada. It is their duty and their endeavor to promote the development of the ceramic industries; to give their aid to the production of better and wider ranges of ware and to the reduction of costs of manufacture.

The ceramic laboratories of the Mines Branch have been equipped for the testing of clays, shales, and other raw materials of the ceramic industries as well as the testing of finished products. There is machinery and apparatus for making ware in order to study problems connected with the various steps of manufacture, and for working out new methods of procedure or developing new products.

The ceramic resources of the country are investigated and attention directed to deposits worthy of economic development.

Individuals or companies contemplating the establishment of a plant are assisted in the selection of locations where suitable raw materials are available or are warned of

technical difficulties likely to arise from the use of material which on testing reveals undesirable qualities.

Manufacturing methods in use in the clay industry are studied not only with a view to improving the products but also to lowering the cost of production. Major investigations are conducted on problems of wide-spread interest involving general principles of manufacture or surmounting common difficulties.

Resulting from one of these investigations certain manufacturers, who for years had struggled unsuccessfully to combat certain troubles, had the danger of financial failure removed and the district served by them also benefited through the availability of not only better looking brick, but brick of much better quality.

Minor investigations not involving the expenditure of much time or money are conducted on many problems of individual or of local importance. Thus manufacturers who are unable to retain ceramic engineers on their staffs are assisted in times of difficulty.

The value of the services being rendered is evidenced by the increasing calls upon the Department for advice and assistance in solving problems peculiar to the industry.

Much remains to be done, for Canada has extensive deposits of raw materials, as yet untouched, suitable for industrial ceramic uses. Her output is yearly increasing and new products are being added constantly. To the experience gained by the industry during the past ages are being added scientific research, engineering skill, and the application of efficient modern methods, all of which are building up a group of industries which will make an enormous contribution to the welfare and prosperity of the Dominion.

CALENDAR OF MEETINGS

Organization	Date	Place
American Assn. for the Advancement of Science	December 28, 1931 to January 2, 1932	New Orleans, La.
AMERICAN CERAMIC SOCIETY	February 7–13, 1932	Washington, D. C.
American Chemical Society	March 30 to April 3	Indianapolis, Ind.
American Electrochemical Society	April 23–25	Birmingham, Ala.
American Foundrymen's Assn.	May 4–7	Chicago, Ill.
American Gas Assn.	October 12–18	Atlantic City, N. J.
American Glassware Mfrs.	July	Atlantic City, N. J.
American Institute of Chemical Engineers	June	Swampscott, Mass.
American Iron and Steel Institute	May 22	New York, N. Y.
American Society of Mechanical Engineers	April 20–23	Birmingham, Ala.
American Society for Testing Materials	June 22–26	Chicago, Ill.
Gypsum Assn.	March 11	Chicago, Ill.
National Assn. of Mfrs. of Heating and Cooking Appliances	May	New York, N. Y.
National Assn. of Mfrs. of Pressed and Blown Glassware	March 10	Pittsburgh, Pa.
National Exposition of Power and Mechanical Engineering	December 5–10	New York, N. Y.
National Glass Distributors Assn.	December 1–3	Pittsburgh, Pa.
National Safety Council	October 12–16	Chicago, Ill.
New Jersey Clay Workers Assn.	June	Asbury Park, N. J.
Scientific Apparatus Makers of America	May	Newport, R. I.
Taylor Society, Inc.	May 1 and 2	Philadelphia, Pa.
Tile & Mantel Contractors' Assn.	April 14–17	Milwaukee, Wis.

AMERICAN CERAMIC SOCIETY

34th Annual Meeting Announced

WASHINGTON, D. C.

Mayflower Hotel

February 7-13, 1932

One of Four good reasons IMPROVED QUALITY *of* WARE

"CARBOFRAX" The CARBORUNDUM Brand
Reg. U. S. Pat. Off. Reg. U. S. Pat. Off.

Silicon Carbide Porcelain Enameling Muffles

WHERE the "Carbofrax" Porcelain Enameling Furnace Muffle is used there is always a decided improvement in the quality of the burned ware.

One outstanding reason is because of the uniformity of the heat flow due to the high thermal conductivity of "Carbofrax"—the Carborundum Brand Silicon Carbide Refractory.

Thus a more uniform burn is obtained.

Because of the absence of spalling of the muffle roof and walls there is no spotting of the ware. Thus is assured a much higher percentage of perfect pieces.

Added to these advantages are increased production—decreased fuel consumption, decreased maintenance costs—greater production of Better Burned Ware.

The Carborundum Company, *Perth Amboy, N.J.*

Harrison & Company, Salt Lake City, Utah ■ Denver Fireclay Co., El Paso, Texas
Christy Firebrick Company, St. Louis, Kansas City, New Orleans, Houston
Pacific Abrasive Supply Co., Los Angeles, San Francisco, Seattle
Williams and Wilson, Ltd., Montreal-Toronto, Canada

(CARBORUNDUM AND CARBOFRAX ARE REGISTERED TRADE MARKS OF THE CARBORUNDUM COMPANY)

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE

A

Aloxite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.

Aluminum Oxide (Fused)
The Exolon Co.
Harshaw Chemical Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bifluoride
Harshaw Chemical Co.
Hommel, O., Co.

Ammonium Carbonate
Harshaw Chemical Co.
Hommel, O., Co.

Antimony Oxide
Harshaw Chemical Co.
Hommel, O., Co.

Auger Machines
Chambers Brothers Co.

Automatic Cutters
Chambers Brothers Co.

Automatic Stove Rooms
Philadelphia Drying Machinery Co.

Automatic Temperature Control
Brown Instrument Co.
Leeds & Northrup Co.

B

Ball Mills
Hommel, O., Co.
McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
Hommel, O., Co.

Barium Carbonate
Harshaw Chemical Co.
Hommel, O., Co.

Barytes
Harshaw Chemical Co.
Hommel, O., Co.

Batts
Carborundum Co. (*"Carbofrax Aloxite"*)
Norton Co. ("Alundum-Crystolon")

Bitstone
Eureka Flint & Spar Co.
Harshaw Chemical Co.
Potters Supply Co.

Blocks (Refractory)
Carborundum Co.
Norton Co.

Boats, Combustion
Norton Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Hommel, O., Co.
Harshaw Chemical Co.
Pacific Coast Borax Co.

Borax Glass
Harshaw Chemical Co.
Pacific Coast Borax Co.

Boric Acid (Anhydrous)
Hommel, O., Co.
Pacific Coast Borax Co.

Boric Acid (Crystal, Granular or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Pacific Coast Borax Co.

Brickmaking Machinery
Chambers Brothers Co.

Bricks (Refractory)
Carborundum Co. (*"Carbofrax Aloxite"*)
Harbison-Walker Refractories Co.
Norton Co. (*"Alundum-Crystolon"*)

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbon Dioxide Meters
Brown Instrument Co.

Carbonates (Barium, Lead)
Harshaw Chemical Co.
Hommel, O., Co.

Caustic Soda
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Cements
Carborundum Co.
Corundite Refractories Co.
Harbison-Walker Refractories Co.
Norton Co.

The National Silica Co.

OREGON, ILL.

Producers and Pulverizers of

FLINT

exclusively for

Pottery Purposes

99.97% Pure Silica **140 Silk Lawn Test**

Ceramic Service? We Give It

We Manufacture—

- Pins
- Stilts
- Thimbles
- Spurs
- Saggers
- Crucibles
- Tile for Decorating Kilns

We Sell—

- Ball Clay
- Sagger Clay
- Wad Clay
- Ground Fire Clay
- Bitstone
- Fire Brick
- Imported Paris White
- Domestic Whiting

THE POTTERS SUPPLY COMPANY

EAST LIVERPOOL, OHIO

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Ceramic Chemicals
Drakenfeld and Co., B. F.
Harbison-Walker Refractories Co.
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

Ceramic Plant Equipment
Chambers Brothers Co.
Harrop Ceramic Service Co.
Philadelphia Drying Machinery Co.

Chromium Oxide
Harshaw Chemical Co.
Hommel, O., Co.

Clay (Ball)
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay & Talc Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (China)
Drakenfeld and Co., B. F.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co.

Clay (Electrical, Porcelain)
Edgar Brothers Co.
Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay and Talc Co.
Spinks Clay Co., H. C.

Clay (Enamel)
Edgar Brothers Co.
Harshaw Chemical Co.
Hommel, O., Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Harbinson-Walker Refractories Co.
Kentucky-Tennessee Clay Co.
Potters Supply Co.

Clay (German Vallendar)
Harshaw Chemical Co.

Clay Handling Machinery
W. S. Tyler Co.

Clay Miners
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay & Talc Co.
Spinks Clay Co., H. C.

Clay (Potters)
Harshaw Chemical Co.
Old Hickory Clay & Talc Co.
Spinks Clay Co., H. C.

Clay (Sagger)
Edgar Brothers Co.
Harbison-Walker Refractories Co.
Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay & Talc Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay Tests
Harrop Ceramic Service Co.

Clay (Wad)
Harshaw Chemical Co.
Kentucky-Tennessee Clay Co
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
Harshaw Chemical Co.
Kentucky-Tennessee Clay Co.
Old Hickory Clay & Talc Co.
Spinks Clay Co., H. C.

Clocks, Gauge Board
Brown Instrument Co.

Cloth (Wire Bolting)
W. S. Tyler Co.

CO_2 Meters
Brown Instrument Co.

Cobalt Oxide
Drakenfeld and Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Numerical Documentation

THE ANNUAL TABLES OF CONSTANTS (A.T.C.)

AND NUMERICAL DATA

Chemical, Physical, Biological and Technological

collect, classify and publish since 1910 everything in Pure and Applied Natural Sciences liable of being expressed by a number.

(For the period 1910–1928) the **A.T.C.** *complete* and

(since 1928) *continue* the International Critical Tables (I. C. T.)

The **A.T.C.** are absolutely necessary to all scientists.

They represent

the only one complete documentation—the most inexpensive—the easiest to consult owing to an *Index* systematically arranged which enables one to locate *at once* the data required.

For any information—any specimen—any volume on free examination

Apply immediately to

Canada and U. S. A.
The McGraw-Hill Book Company, Inc.
370 Seventh Avenue
New York, U. S. A.

Other countries
M. C. MARIE
9, rue de Bagneux
Paris VI° France

Volumes published: 1st Series—I to V—1910–1922 (5382 pages) and Index
2nd " VI & VII—1923–1926 (3571 pages)

Specimens: Reprints of the following sections are sent free of charge: Spectroscopy—Electricity, Magnetism, Electrochemistry—Radioactivity—Crystallography, Mineralogy—Biology—Engineering and Metallurgy—Colloids—Wireless—Photography—Geophysics—Combustible gaseous mixtures, Powders and Explosives.

English versions: Beginning with Volume VII, all explanations to the tables are given in both English and French.

THE DAY WILL COME

when you will want a certain article in a three-year-old issue of some technical journal—and want it quick.

THAT IS THE DAY

to remember that more than one million back numbers of important magazines are waiting for your call on the shelves of the

Periodicals Department

THE H. W. WILSON COMPANY

964 University Avenue **New York City**

No trouble to quote prices
Periodicals bought and sold. Photostat service.

The Journal of the Society of Glass Technology

A quarterly Journal containing original papers and abstracts of papers covering the whole field of Glass Technology.

ANNUAL SUBSCRIPTIONS TO SOCIETY (Including Journal)

Ordinary Members	**$ 7.50**
Collective Members	**15.00**
Price per Number to non-Members	**2.50**
Price per Volume (unbound) to non-Members	**9.00**

Forms of application for membership may be obtained from the American Treasurer of the Society, Francis C. Flint, Washington, Pa.

Address orders and inquiries to: The Secretary, Society of Glass Technology, The University, Sheffield, England

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Colors
Drakenfeld and Co., B. F.
Harshaw Chemical Co.
Hommel Co., O.
Vitro Mfg. Co.

Combustion Apparatus
Leeds & Northrup Co.

Conditioning Machinery
Philadelphia Drying Machinery Co.

Cones (Filter)
Norton Co.

Controllers
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Conveyers (Clay, Sand, Brick, etc.)
Philadelphia Drying Machinery Co.

Cores (Alundum Furnace)
Norton Co.

Cornwall Stone
Eureka Flint & Spar Co.
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Pulverizing Co.

Cornwall Stone (Imported)
Harshaw Chemical Co.

Crucibles (Filter, Melting, Ignition)
Norton Co.
Potters Supply Co.

Crushers
Chambers Brothers Co.

Cryolite
Harshaw Chemical Co.
Hommel, O., Co.

D

Decorating Supplies
Drakenfeld and Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Dishes (Alundum, Filtering, Ignition)
Norton Co.

Disintegrators
Chambers Brothers Co.

Disks (Alundum, Porous, Filter)
Norton Co.

Dolomite
Harshaw Chemical Co.

Driers
Harrop Ceramic Service Co.

Driers (China Ware, Porcelain)
Philadelphia Drying Machinery Co.

Drying Machinery
Philadelphia Drying Machinery Co.

E

Electrical Instruments
Brown Instrument Co.
Leeds & Northrup Co.

Electrical, Porcelain
Old Hickory Clay & Talc Co.

Enameling Equipment, Complete
Chicago Vitreous Enamel Products Co.
Ferro Enamel Corp.

Enameling Furnaces
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Vitro Mfg. Co.

Enameling Muffles
Carborundum Co. (*Carbofrax*)

Enameling, Practical Service
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Vitro Mfg. Co.

Enamels
Harshaw Chemical Co.
Hommel, O., Co.

Enamels, Porcelain
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Vitro Mfg. Co.

H. W. R. SAGGER CLAY
and
H. W. R. —D— CLAY

For Your Complete Sagger Batch

Write for Complete Information

HARBISON-WALKER REFRACTORIES CO.
World's Largest Producer of Refractories
Pittsburgh, Pa., U.S.A.

Offices in Principal Cities

BORAX *Guaranteed 99½%–100% Pure* **BORIC ACID**

Select the Brand which has back of it years of *successful use* by experienced Ceramists

Pacific Coast Borax Co., New York

Chicago Los Angeles

Refractory Materials
Products of the Electric Furnace

SILICON CARBIDE
SILICON CARBIDE FIRESAND
ARTIFICIAL MULLITE
FUSED ALUMINUM OXIDE
FUSED MAGNESITE

Furnished in raw material form, ground to meet specifications.

Our Research Department with fully equipped laboratories is always at your service.
WRITE US ABOUT YOUR PROBLEMS

THE EXOLON COMPANY
Established 1914

Electric Furnace Plant { THOROLD, ONTARIO

Finishing Plant, General Offices { BLASDELL, N. Y.

BUYERS' GUIDE (continued)

Engineering Service
Chambers Brothers Co.
Harrop Ceramic Service Co.

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.

Exolon (Refractory Products)
The Exolon Co.

Equipment (Safety)
Willson Products, Inc.

Extruding Machines (Lab. Use)
Chambers Brothers Co.

F

Fans
Philadelphia Drying Machinery Co.

Feldspar
Eureka Flint & Spar Co.
Golding-Keene Co.
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Pulverizing Co.
Southern Feldspar, Inc.
Standard Flint & Spar Co.

Filter Cloth (Wire)
W. S. Tyler Co.

Fire Brick
Carborundum Co.
Harbison-Walker Refractories Co.

Flint
Eureka Flint & Spar Co.
Golding-Keene Co.
Harshaw Chemical Co.
National Silica Co.
Pennsylvania Pulverizing Co.
Southern Feldspar, Inc.
Standard Flint & Spar Co.

Flint Pebbles
Eureka Flint & Spar Co.
Harshaw Chemical Co.
Hommel, O., Co.

Flow Meters
Brown Instrument Co.
Leeds & Northrup Co.

Frit
Vitro Mfg. Co.

Furnace
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Harrop Ceramic Service Co.
Simplex Engineering Co.

Furnaces (Electrical Laboratory Type)
Engelhard, Chas., Inc.

G

Gas Analysis Meters
Brown Instrument Co.

Gauges (Indicating, Recording, Controlling; Draft; Depth; Liquid Level; Pressure; Remote; Temperature; Vacuum)
Brown Instrument Co.

Glass Tanks
Simplex Engineering Co.

Glass Plant
Simplex Engineering Co.

Glaze and Body Spar
Harshaw Chemical Co.
Hommel, O., Co.

Glazes and Enamels
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Glaze Spar
Eureka Flint & Spar Co.
Harshaw Chemical Co.
Hommel, O., Co.

Goggles
Willson Products, Inc.

Gold
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Guards (Safety)
W. S. Tyler Co.

H

Hearths
Carborundum Co.
(*Carbofrax* heat treating)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

To our Advertisers:

Are your listings in the **BUYERS' GUIDE** correct? If **YOU** desire additional listings, do not hesitate to write us.

Since 1848
Importers of

ENGLISH CHINA CLAYS
ENGLISH BALL CLAYS
CORNWALL STONE
TALC (STEATITE)

Dependable Qualities of Ceramic Materials for all Branches of the Industry

HAMMILL & GILLESPIE, INC.
225 Broadway
New York

Pyrometer Tubes—Protection Tubes—Combustion Tubes
McDanel Refractory Porcelain Company
Beaver Falls, Pennsylvania

UNUSUAL · SHAPES · OUR · SPECIALTY

PENNSYLVANIA SALT MANUFACTURING COMPANY

Executive Offices: Philadelphia, Pa.

Works: Philadelphia and Natrona, Pa., Wyandotte and Menominee, Mich.

Representatives:
New York Chicago
Pittsburgh St. Louis

PENNA. SALT MANUF'G. CO.
PURE
GREENLAND KRYOLITH
PHILADELPHIA, PA

1. **Are you out of a job?**
2. **Would you like a new job?**
3. **Are you looking for a high class man to fill some vacancy?**

Our Classified Advertising rates are 35 words for $1.00

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Humidity Control
Leeds & Northrup Co.

Hydrogen Ion Equipment
Leeds & Northrup Co.

Hygrometers
Brown Instrument Co
Leeds & Northrup Co.

I

Indicators & Recorders (Steam, Air, Gas)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Indicators, Chemical
Leeds & Northrup Co.

Infusorial Earth
Harrop Ceramic Service Co.

Instruments (Temperature, Pressure)
Brown Instrument Co.
Leeds & Northrup Co.

Iron (Enameling)
American Rolling Mill Co.

K

Kaolin
Edgar Brothers Co.
Harshaw Chemical Co.
Hommel, O., Co.

Kilns
Harrop Ceramic Service Co.
Simplex Engineering Co.

Kilns (China, Decorating)
Drakenfeld & Co., B. F.
Hommel, O., Co.

Kryolith
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Salt Mfg. Co.

L

Laboratory Supplies
W. S. Tyler Co.

Law
W. S. Tyler Co.

Leers (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

Leers (Low Heat, Muffle Type, Electric)
Simplex Engineering

Level Gauges (Indicating, Recording, Controlling; Boiler; Liquid; Water)
Brown Instrument Co.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Carborundum Co.
Harbison-Walker Refractories Co.
Norton Co.

Liquid Level Indicator and Recorder
Brown Instrument Co.
Leeds & Northrup Co.

M

Magnesia (Sintered, Calcined)
The Exolon Co.
Harbison-Walker Refractories Co.

Magnesite
Drakenfeld & Co., B. F.
Harbison-Walker Refractories Co.
Harshaw Chemical Co.
Hommel, O., Co.

Manganese
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Manometers
Brown Instrument Co.

Masks (Breathing)
Willson Products, Inc.

Metals (Porcelain Enameling)
American Rolling Mill Co.

Meters (All Kinds)
Brown Instrument Co.
Engelhard, Chas., Inc.

Microscope
Bausch & Lomb Optical Co.

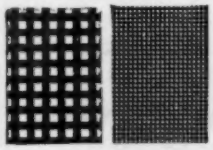
Millivoltmeters (Indicating, Recording, Controlling)
Brown Instrument Co.

Minerals
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Mixing Machines
Chambers Brothers Co.

Motors
Harrop Ceramic Service Co.

Muffles (Furnace)
Carborundum Co. (*Carbofrax*)
Corundite Refractories Co.
Norton Co.



WOVEN WIRE SCREENS
TESTING SIEVES
HUM-MER *Electric* SCREEN

THE
W. S. TYLER
COMPANY

CLEVELAND
OHIO
U. S. A.

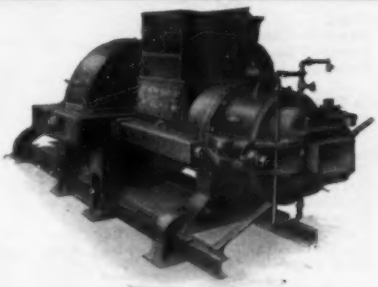
For BETTER
Glasshouse CLAY POTS and TANK BLOCKS
Insist on getting
GROSSALMERODE CLAY

Sold since 1865
by
J. GOEBEL & CO.
95 Bedford St.
NEW YORK

Brick Making Machines

Crushers Grinders Mixers
Automatic Cutters

Chambers Bros. Co.
Philadelphia Pennsylvania



EUREKA
FLINT & SPAR Co., Inc.

MINERS, IMPORTERS AND PULVERIZERS

Pure English Cornwall Stone

Imported French Flint	Connecticut Feldspar
French Placing Flint	New Hampshire Feldspar
American Rock Flint	New York Feldspar
American Sand Flint	Carolina Feldspar
Eureka #1 Feldspar	Maine Feldspar

Eureka Specially Selected Glaze Spar has been famous for Twenty Years for its Brilliant Lustre

EUREKA FLINT & SPAR CO.
INCORPORATED
Trenton-New Jersey

BUYERS' GUIDE (continued)

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

N

Nitrates (Cobalt, Sodium)
Harshaw Chemical Co.
Hommel, O., Co.

O

Opacifiers
Harshaw Chemical Co.
Hommel Co., O.
Titanium Alloy Mfg. Co.

Orifice Plates
Brown Instrument Co.

Oxides
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel Co., O.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

P

Pans (Wet and Dry)
Chambers Brothers Co.

Pebble Mills
Hommel, O., Co.

Petrographic Microscope
Bausch & Lomb Optical Co.

Pins
Potters Supply Co.

Placing Sand
Eureka Flint & Spar Co.
National Silica Co.
Pennsylvania Pulverizing Co.

Plant Design
Harrop Ceramic Service Co.

Plate Feeders
Chambers Brothers Co.

Plate (Filter)
Norton Co.

Polariscope
Simplex Engineering Co.

Porcelain Enameling Service, Practical
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Vitro Mfg. Co.

Porcelain Enamels
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Vitro Mfg. Co.

Pot Furnaces
Simplex Engineering Co.

Potash (Carbonate)
Harshaw Chemical Co.
Hommel, O., Co.

Potassium Bifluoride
Harshaw Chemical Co.
Hommel, O., Co.

Potentiometers (Indicating, Recording, Controlling)
Brown Instrument Co.

Producer Plants
Simplex Engineering Co.

Protecting Tubes, Pyrometer
Leeds & Northrup Co.

Protecting Tubes, Thermocouple
Brown Instrument Co.

Protective Equipment
Willson Products, Inc.

Pug Mills
Chambers Brothers Co.

Pulverizing Mills
Hommel, O., Co.

Pyrometers (Indicating)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometers (Optical)
Leeds & Northrup Co.

Pyrometers (Recording)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer (Switches)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer Thermocouples
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Pyrometer Tubes (Refractory and Hard Porcelain)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

SOME PUBLICATIONS YOU SHOULD OWN

Issued by

THE AMERICAN CERAMIC SOCIETY

(1) Branner's Ceramic Literature (1906)
451 pages. Titles only. $0.50

(2) Refractories: Silica, Magnesite, and General (1925)
330 pages. Titles and abstracts. 2.00

(3) Collective Index for Transactions
Volumes I to XIX, inclusive. 0.50

(4) Scumming and Efflorescence Bibliography
Reprints from Vol. 8, No. 8, 1925. 23 pages. No charge

(5) Standard Methods and Specifications
Ceramic Materials and Products (1928). 230 pages. 2.00

(6) Seger's Collected Writings
2 Volumes. 15.00

(7) Enamel Bibliography (1929)
500 pages. 2.00

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

R

Recorders (CO, CO_2, SO_2 and Draft)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Recording Instruments
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Refractories
Carborundum Co.
The Exolon Co.
Harbison-Walker Refractories Co.
Norton Co.

Refractory Materials
The Exolon Co.
Harbison-Walker Refractories Co.

Regulators (Automatic Temperature)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Remote Controllers, Indicators, Recorders
Brown Instrument Co.

Respirator
Willson Products, Inc.

Rutile
Titanium Alloy Mfg. Co.

S

Safety Devices
Willson Products, Inc.

Sagger Presses
Chambers Brothers Co.

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.

Screening Machinery
W. S. Tyler Co.

Screens (Cloth, Electric Vibrating)
W. S. Tyler Co.

Selenite of Sodium
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Vitro Mfg. Co.

Selenium
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Separators (Inclined Vibrating)
W. S. Tyler Co.

Shakers (Testing Sieve)
W. S. Tyler Co.

Sieves (Testing)
W. S. Tyler Co.

Silica Blocks
Eureka Flint & Spar Co.

Silica (Fused)
The Exolon Co.

Silicate of Soda
Philadelphia Quartz Co.

Silicon Carbide
The Exolon Co.

Silicon Carbide Firesand
The Exolon Co.

Sillimanite (Synthetic)
The Exolon Co.
Harshaw Chemical Co.
Norton Co.

Slabs (Furnace)
Carborundum Co.
Norton Co.

Smelters
Chicago Vitreous Enamel Product Co.

Soda Ash
Harshaw Chemical Co.
Hommel, O., Co.

Sodium Antimonate
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.
Vitro Mfg. Co.

Sodium Fluoride
Harshaw Chemical Co.
Hommel, O., Co.

Spar
Harshaw Chemical Co.
Hommel, O., Co.
Pennsylvania Pulverizing Co.

Spurs
Potters Supply Co.

Stilts
Potters Supply Co.

Sulphuric Acid
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Pennsylvania Salt Mfg. Co.

Switches
Brown Instrument Co.

T

Tachometers
Brown Instrument Co.
Leeds & Northrup Co.

B O R A X

AND

BORIC ACID

* * *

GUARANTEED
OVER 99½% PURE

AMERICAN POTASH &
CHEMICAL CORPORATION
Woolworth Bldg., New York City

LUSTERLITE ENAMELS

THERE is satisfaction in knowing that the frit you purchase is of the finest quality and that the service is dependable.

There is greater satisfaction in knowing that the frit is *uniformly* fine and that the service is *consistently* dependable.

When you buy Lusterlite Frit you buy *product finish insurance.*

Chicago Vitreous Enamel
Product Co.
CICERO ILLINOIS

COBALT

URANIUM

CHROME

THE VITRO MFG. CO. PITTSBURG, PA.

Vitrifiable Glass Colors » » »

Enamel Colors »

Pottery Colors »

ENAMELS FOR SHEET STEEL
AND CAST IRON » » » »

All Products
Laboratory Controlled

VITRO
MANUFACTURING CO.
CORLISS STATION
PITTSBURGH, PA.

(When writing to advertisers, please mention the JOURNAL)

BUYERS' GUIDE (continued)

Talc
Hammill & Gillespie, Inc.
Harshaw Chemical Co.
Hommel, O., Co.

Tanks
Simplex Engineering Co.

Temperature Controls
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Temperature Instruments (Measuring)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thermocouples
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thermometers (Electric Resistance, Indicating, etc.)
Brown Instrument Co.
Engelhard, Chas., Inc.
Leeds & Northrup Co.

Thimbles (Filtering Extraction)
Norton Co.

Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Harbison-Walker Refractories Co.

Tin Oxide
Drakenfield & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.
Metal & Thermit Corp.

Titanium
Harshaw Chemical Co.
Hommel, O., Co.
Titanium Alloy Mfg. Co.

Tubes (Insulating)
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

Tubes (Pyrometer)
Brown Instrument Co
Engelhard, Chas., Inc.
Leeds & Northrup Co.
McDanel Refractory Porcelain Co.
Montgomery Porcelain Products Co.

V

Valves (Automatic Control)
Brown Instrument Co.
Engelhard, Chas., Inc.

Venturi Meters
Brown Instrument Co.

Vibrating Screens
W. S. Tyler Co

V-Notch Meters
Brown Instrument Co.

W

Wet Enamel
Chicago Vitreous Enamel Product Co.
Vitro Mfg. Co.

Whiting
Drakenfeld & Co., B. F.
Harshaw Chemical Co.
Hommel, O., Co.

Wire Cloth
W. S. Tyler Co.

Witherite
Harshaw Chemical Co.

Woven Wire
W. S. Tyler Co.

Z

Zirconia
Harshaw Chemical Co.
Hommel, O., Co.
Titanium Alloy Mfg. Co.
Vitro Mfg. Co.

We will soon market two new Clays
THE CHAMPION
THE CHALLENGER
Write us for further information.
H. C. SPINKS CLAY COMPANY
Newport, Ky.
Chicago Office: 236 N. Clark St.

ALPHABETICAL LIST OF ADVERTISERS

American Potash & Chemical Corp. 23
American Rolling Mill Co. 2
American Telephone & Telegraph Co. 6
Carborundum Co. 9
Ceramic Educational Directory. 7a & 7b
Chambers Bros. Co. 19
Chicago Vitreous Enamel Product Co. 23
Classified Advertising. 26
Drakenfeld & Co., B. F., Inc. Inside Front Cover
Edgar Bros. Co. 4
Edgar Plastic Kaolin Co. 4
Eureka Flint and Spar Co., Inc. 19
Exolon Co. 15
Ferro Enamel Corp. 27
Goebel, J. & Co. 19
Golding-Keene Co. 28
Hammill & Gillespie, Inc. 17
Harbison-Walker Refractories Co. 15
Hommel, O., Co. Inside Back Cover
Journal of the Society of Glass Technology. 13
Kentucky-Tennessee Clay Co. 3
Leeds & Northrup Co. 1
McDanel Refractory Porcelain Co. 17
Metal & Thermit Corp. Outside Back Cover
National Silica Co. 11
Pacific Coast Borax Co. 15
Pennsylvania Pulverizing Co. 4
Pennsylvania Salt Mfg. Co. 17
Philadelphia Drying Machinery Co. 28
Philadelphia Quartz Co. 27
Potters Supply Co. 11
Professional Directory. 26
Simplex Engineering Co. 27
Southern Feldspar, Inc. 28
Spinks, H. C., Clay Co. 24
Standard Flint & Spar Corp. 28
Tables Annuells de Constantes & Donnees Numeriques. 13
Titanium Alloy Mfg. Co. Center of Book
Tyler, W. S., Co. 19
Vitro Mfg. Co. 23
Willson Products, Inc. 3
Wilson, H. W., Co. 13

(When writing to advertisers, please mention the JOURNAL)

PROFESSIONAL DIRECTORY

THE SHARP-SCHURTZ CO.
Chemists for the Ceramic Industry
We have fully equipped laboratories at
Lancaster, Ohio, U. S. A.

Petrographic Laboratory
W. Harold Tomlinson
Microscopic examinations.
All petrographic work.
114 Yale Ave.
Swarthmore, Pennsylvania

Established 1836
BOOTH, GARRETT & BLAIR
Analytical & Consulting
CHEMISTS
Accurate analyses of all types
of Ceramic Materials
Feldspar, Clay, Sand, Colors
Glass, Enamels, etc.
404-406 LOCUST STREET
PHILADELPHIA, PA.
The oldest commercial laboratory in America

DOWNS SCHAAF
Chemical & Metallurgical Engineer
Special Analyses
Research Projects
1433 Studer Ave. Columbus, Ohio

CLASSIFIED ADVERTISING

GRADUATE CERAMIST — two years' experience in tile industry doing glaze and control work on wall and floor tile and casting slips. Interested in research or production work for any clay products manufacturer, preferably whitewares. Address Box 116-D, American Ceramic Society, 2525 N. High St., Columbus, Ohio.

PLANT ENGINEER familiar with modern Tunnel Kiln equipment including Drying — Conveying and Power Plants. If interested, state offer. Locality no objection. Address Box 115-E, American Ceramic Society, 2525 N. High St., Columbus, Ohio.

The Cost of Classified Advertising Is 35 Words for $1.00 and 5c for Each Word Additional

(When writing to advertisers, please mention the JOURNAL)

"SS—Powdered—20"

SILICATE OF SODA

for

ACID-RESISTANT ENAMELWARE

Samples and further information without obligation.

PHILADELPHIA QUARTZ COMPANY

121 S. Third St., Philadelphia

Chicago Office: 205 W. Wacker Drive

1831—Beginning Another Century—1931

The Ferro Enamel Corporation

"Makers of Fine Enamel for Many Years"

Cleveland, Ohio

ENAMELS
EQUIPMENT
ENAMELING
FURNACES
SUPPLIES

Representatives at Philadelphia, Louisville, Oakland, Calif., Ottawa, Canada, Rotterdam, Holland, and Birmingham, England.

KILNS
LEHRS—Ovens
TANKS—Furnaces
Producer Plants
Oil Systems
Batch Plants
Buildings
Fourcault Plants
Appraisals
Complete Factories
Power Plants

4 REASONS why you should buy Simplex Equipment:

(1) Unique Engineering Designs
(2) Phenomenal Positive Results
(3) Highly Efficient
(4) Very Low Maintenance Cost

SIMPLEX ENGINEERING COMPANY

Washington Trust Building A

Washington, Pennsylvania, U. S. A.

IDEAL DRYING and increased production with "HURRICANE" DRYERS

Truck tray dryer for grinding wheels

"HURRICANE" Drying, with temperatures and Humidity automatically Controlled and Air Currents correctly distributed, results in faster drying, higher quality ware and less spoilage.

"Hurricane" Dryers are made in Tray, Truck and Continuous Conveyor types for pottery, spark plugs, insulators, refractory materials, tile, enamel ware, brick, and all other ceramic products. 208

THE PHILADELPHIA DRYING MACHINERY CO.
3351 Stokley Street, Philadelphia, Pa.
DRYERS for ALL Ceramic Products

FELDSPARS ★★ FLINTS

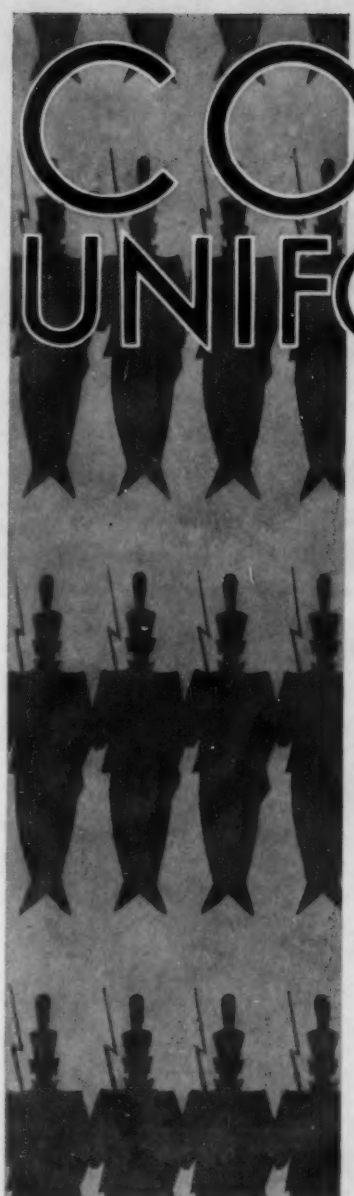
"Great Stone Face" Profile Notch, N. H.

GOLDING-KEENE COMPANY
KEENE, NEW HAMPSHIRE

THE STANDARD FLINT & SPAR CORP.
TRENTON, NEW JERSEY

SOUTHERN FELDSPAR, INC.
TOECANE, NO. CAROLINA

Near YOU Wherever YOU Are



COLOR UNIFORMITY

The O. Hommel Co. believes that absolute uniformity of color is of vital importance. Every shipment is carefully checked to match identically every previous lot.

Factory and Laboratory controlled colors, under the constant watch of a staff of experienced color experts, give you the assurance of reliability.

You will appreciate this factor resulting in the elimination of unnecessary grief if you procure your color requirements from "Hommel," Pittsburgh.

Known for their strength, purity and uniformity, "Hommel" Colors are recognized as "Standard" for the Ceramic industry.

THE O. HOMMEL CO., INC.

209-4th AVE. PITTSBURGH, PA.

N. Y. OFFICE
421-7th Ave.

Factory at
Carnegie, Pa.

Technical Control

The watchwords in making

M and T ENAMELS

M and T enamels are made in the newest and most modern enamel smelting plant in the country.

Each operation is conducted under the strictest of technical control. Quality of chemicals, weighing and mixing are controlled by a system that is "fool-proof."

The actual smelting is done under the direct supervision of men with years of experience in smelting enamels. Only fuel free from sulphur is used.

Quality and quantity of fuel, time, temperature, furnace atmosphere, rate of melting, degree of melting and final uniformity of melting are under strict control at all times. No detail is left to the personal opinions of the operators.

Finally each melt is subjected to an elaborate series of chemical and physical tests in which it must meet predetermined standards of quality and uniformity.

Our organization has been "SHOOTING TROUBLE" *in enamel shops for over ten years.*

It must be right in every particular or it does not go out.

Metal & Thermit Corporation

CERAMIC DEPARTMENT

HOMER F. STALEY • MANAGER
R. R. DANIELSON • DIRECTOR OF RESEARCH
120 BROADWAY, NEW YORK CITY